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AUGUST 1st, 1951 VOL. 6, NO. 6 1/10

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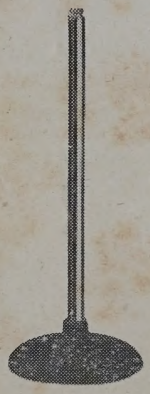

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RADIO AND ELECTRONICS

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OUR COVER

This month we illustrate the actual appearance of the Image Orthicon TV Camera Tube, the working of which is described on page 12 of this issue.

●

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THE "R. & E." 1951 V.H.F. Programme

Elsewhere in this issue is a short article describing a co-ordinated series of practical constructional articles which are to be presented in these pages under the collective title of the "R. & E." 1951 V.H.F. Programme. This scheme is a new departure, not only for this journal, but also, it is thought, for any technical periodical. The idea behind the series, and the scope of the articles are described in the article referred to above. On the receiver side, it is thought that our own ideas will in all probability be quite adequate, but apart from this, there is a great deal of room for difference of opinion and, in particular, for different requirements.

This applies more particularly to transmitting circuits. In addition to straight-out receiving and transmitting gear, there is the interesting problem of ancillary equipment. For V.H.F. bands, it is no less necessary than at lower frequencies to have available absorption frequency meters, modulation monitors, and the other small but invaluable pieces of test equipment that enable one to work with so much more sureness, speed, and satisfaction. In fact, it is really more necessary to have these things on the V.H.F. bands than at lower frequencies.

The main idea behind the V.H.F. programme, as we have said elsewhere, is to assist those amateur transmitters who feel that with a little help in the way of suitable published articles, they could make a start in this new and intriguing territory. They will also, we hope, be of some value to those who have been put off by the difficulties, imagined or real, of V.H.F. gear; from this it should not be inferred that the articles, or the equipment described in them, are elementary only. It is our theory that the amateur can build just as good transmitters and receivers for very high frequencies as he often does for the lower ones, and, what is more important, that the one is no more difficult than the other.

To this end, we would hereby invite any of our readers who expect to be taking an interest in the V.H.F. Programme, to send us their suggestions for any V.H.F. equipment they would like to see incorporated. We cannot, of course, guarantee to fall in with all suggestions, but will do our best to make the series as interesting and useful as possible to the greatest number of V.H.F. enthusiasts.

Technical Matters And The Daily Press

There was recently reported in the daily newspapers, a statement that engineers overseas had developed a system of high-frequency communication that resolved the time-honoured argument of A.M. versus F.M. by the simple expedient of getting so much better results than either, to make the old controversy of purely academic interest.

The report went on to state that the "new system" referred to was probably pulse modulation.

Now this is the sort of reporting on technical matters that is, to say the least of it, unfortunate. In the first place, while technical people generally would be the last to say that a thing is impossible, it does appear that unless someone has invented something which is really a revolutionary principle, the subject of the report is just not attainable. Secondly, if the report really is about pulse modulation, then it is at the same time completely erroneous. The paragraph read as if the "new principle" had only very recently been developed, and if this is so, it can hardly be pulse modulation, which has been used for communication purposes for a number of years now, BUT NOT ON THE H.F. PART OF THE SPECTRUM, AS WAS STATED IN THE ARTICLE. Add to this the fact that pulse modulation could hardly be used for long-distance communication on the H.F. bands, owing to its excessive bandwidth requirement, and the intereference it would cause on nearby channels, and it is fairly obvious that the so-called news paragraph contains no *useful* information whatever.

While this sort of thing is greatly to be deplored, being misleading to the uninitiated, and merely annoying to technical people, it is understandable that it occurs, in view of the news value of technical advances in this predominantly technological age. Nevertheless, the Press prides itself on accurate and truthful reporting, so that according to its own principles, there is no excuse for badly informed and quite misleading reporting of this nature. Clearly, press reporters cannot be experts in engineering or technology of any kind, but such experts are available for consultation, and it would not be a difficult matter for technical reports to be "vetted" by someone who could ensure that they mean something, although expressed in non-technical language, and that any opinions expressed are, at least, within the bounds of probability. The example to which we have referred is a glaring case of a paragraph which contained no vestige of genuine information to any reader, technical or otherwise, and scarcely reflects credit on those responsible for promulgating it.

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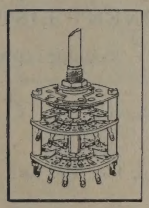

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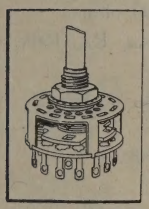

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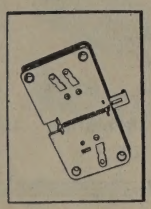

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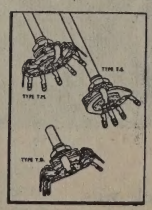

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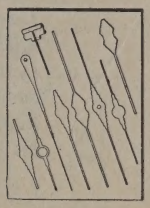

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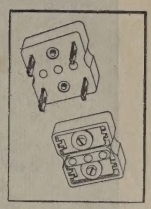

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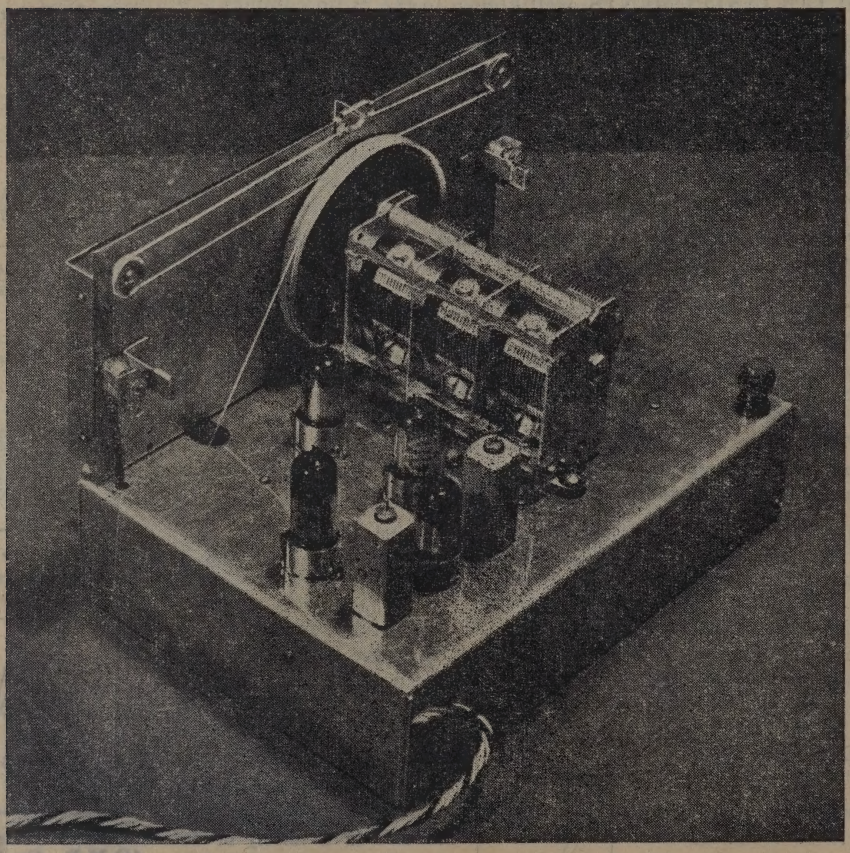
An All-Wave Tuner for Use With a Separate Audio Amplifier

Last month we described a special local station tuner designed to be used with an existing high-quality amplifier. Provision was made for adding to the system a second, general-purpose tuner to give distant broadcast and short-wave reception. The present article describes this general-purpose tuner, which, however, need not be used in conjunction with the other, since it can equally as well stand on its own merits, and will give better than average results if used with a good audio amplifier.



COMPONENT LIST

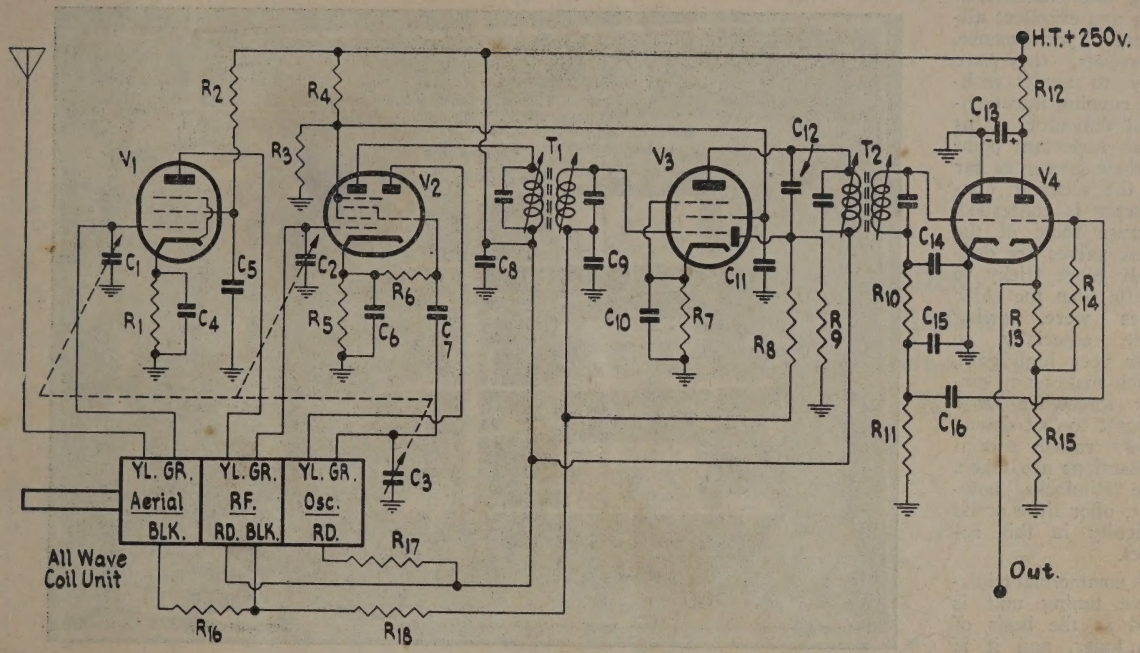
C_1, C_2, C_3, 3-gang condenser.
C_4, C_5, C_6, C_9, C_{10}, C_{11}, 0.05 μf.
C_7, C_{12}, C_{14}, C_{15}, 100 $\mu\mu$f.
C_8, 0.5 μf.
C_{13}, 8 μf. 450v. electro.
C_{16}, 0.01 μf.
R_1, R_7, 300 ohms.
R_2, R_{15}, R_{16}, R_{18}, 100k.
R_3, 25k.
R_4, R_6, 20k.
R_5, R_9, R_{14}, 1 meg.
R_{10}, R_{12}, 50k.
R_{11}, 50k.
R_{13}, 1.5k.
R_{17}, 30k.
V_1, EF41.
V_2, ECH42.
V_3, EAF42.
V_4, ECC40.
T_1, T_2, miniature 455 kc/sec. I.F.T.s.

INTRODUCTION

The radio tuner to be described in this short article was designed specially for those who wish to use an existing high-quality audio amplifier as part of their radio receiving system as well as for its primary purpose of playing gramophone records. At the outset, it should be emphasized, however, that the present tuner does not claim to give high-fidelity results. In most respects, it is exactly similar to the corresponding portion of any good domestic set incorporating a stage of R.F. amplification ahead of the mixer, and all-wave frequency coverage as it is usually understood today. It has, however, a number of advantages when compared with the average "front end" that might be copied from almost any manufacturer's circuit diagram. Of these, the chief is that it has special output arrangements, which enable it to be fed over quite long lengths of line to the amplifier, should this be necessary.

FEATURES INCORPORATED IN THE TUNER

Perhaps the most noteworthy thing about the circuit is the use of the latest of the new "Rimlock" series of valves. These valves do not seem to have become very popular among constructors (although several manufacturers are making good use of them) and this has rather surprised us, for they are an excellent series of tubes,



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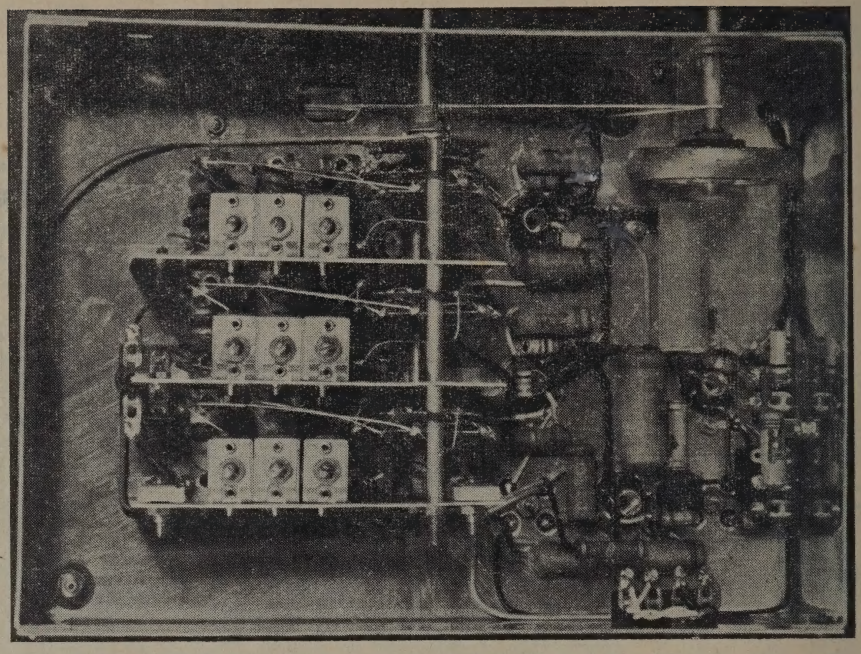
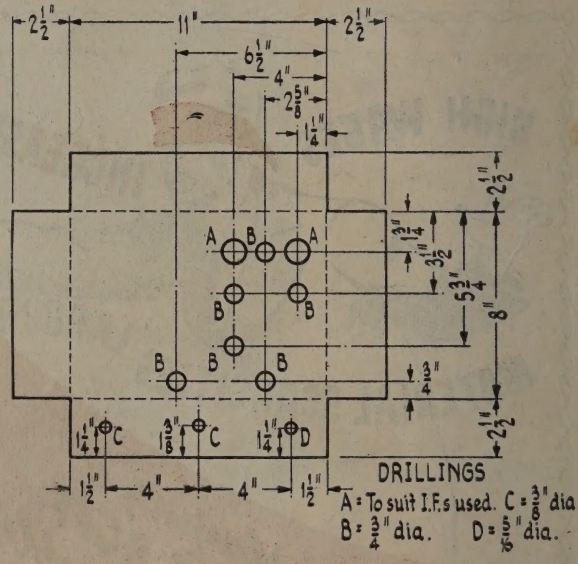
with fine characteristics, and excellent all-round performance. Moreover, they are easy to apply without running into technical difficulties. This is an important point in their favour as far as the amateur constructor is concerned, because some of the latest valves are definitely more tricky to handle than the older types were, owing more especially to their very high gain, which makes any circuit somewhat more difficult to "sit down" unless rather special precautions are taken. The "Rimlocks," however, offer little or no difficulty in this respect.



A commercial triple-wave tuning unit is used as the basis of the tuner, and it is quite remarkable how easily one can obtain really good performance on all bands with one of these units. The maker has, of course, done all the really hard work, such as designing a suitable coil layout, wiring up the wave-change switch, etc., that were at one time the bane of the amateur constructor building himself an all-wave set. As long as the unit is well and truly screwed down, and stage and condenser gang earths are made in the right places, there is nothing to prevent the veriest tyro from making a highly successful job of things.

The R.F. stage and oscillator-mixer stage are conventional, and call for no special comment. The first point of importance is the arrangement of the detector, A.V.C., and output stages. It will be seen that an EAF42 is used as the I.F. amplifier and A.V.C. rectifier. As we have mentioned before, this idea of putting the A.V.C. diode and the I.F. amplifier pentode in the same envelope is an excellent one, enabling one to observe the cardinal rule of good R.F. layout, namely, "keep live R.F. leads as short as possible." And, we may add, when the live lead concerns the plate of the I.F. stage, where there may be up to 30 volts of signal, the ideal to aim at is to make it even shorter! Having decided to do this, the question immediately arises of where the detector diode is to come from. Since the EAF42 contains only one diode plate, it cannot be here. In any case, the practice of putting the detector and A.V.C. diodes both with the I.F. amplifier, though sound, does tend to cause a certain amount of congestion on this part of the chassis. It had been decided, of course, that a cathode follower output stage should be used so as to make the tuner as versatile as possible when it comes to using it with a separate audio amplifier, as intended. This stage would also be a very good thing for the audio quality of the tuner, as it puts an almost negligible shunt on the detector load resistor, and will enable the diode to handle high modulation percentages without distortion. For this purpose, one half of the double triode ECC40 would be admirably suited, and since the output of the detector would be several volts, no audio amplifier stage would be needed. The second triode would, therefore, be free



Working drawing for the chassis

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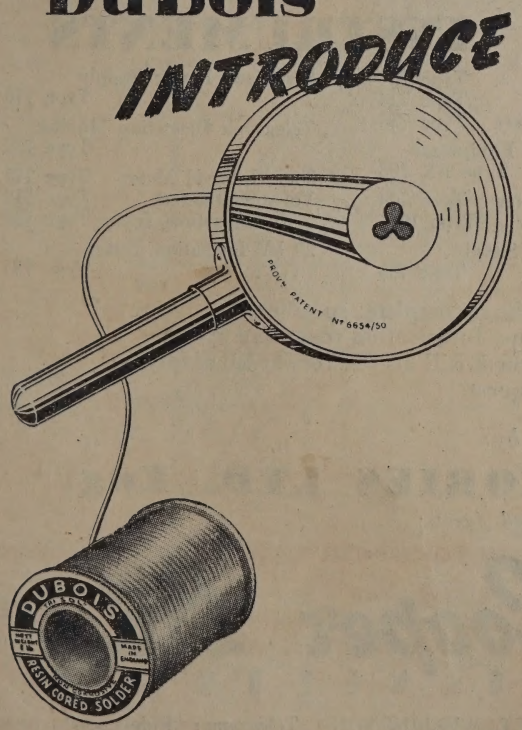

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for use as the second detector. In case some readers may wonder whether we have invented a new detector circuit, we would like to point out that we have not. The cathode and grid of the triode section are used as a completely normal diode detector, with the grid acting as the plate, while the actual plate has been earthed. This is a very good plan, as the plate, which completely surrounds the grid and cathode, acts as a very effective eelctrostatic shield, making it quite unnecessary to put a shield round the outside of the tube itself. In passing, it might be mentioned that the "Rimlocks" do not need an external shield, as they have one built into the tube itself in the cases of the mixer and R.F. pentodes.

By means of the arrangement just discussed, we have a tuner containing no more valves than the conventional four, and yet providing a cathode follower output tube, and the special advantages which this confers. Incidentally, it would be well worth while to use exactly this arrangement in a set which contained its own audio stages, because of the excellent detector performance, and because of the flexibility in positioning the audio section obtained when the first audio stage can be as far as we please from the detector.

CONSTRUCTION

The two photographs and the chasis diagram give an excellent idea of the layout of the tuner, so that it should not be necessary to say very much about it. The front tube nearest the gang condenser is the R.F. stage, with the ECH42 behind it. The front tube nearest the right-hand edge of the chassis is the ECC40. There always appears to be a good deal of waste space about a chassis in which one of these coil units is used, but the impression is illusory, as a glance at the underneath view will show. Space not occupied above the chassis is mostly taken up underneath.

Since this was primarily intended to go with the tuner described last month, the circuit does not show a power supply, but in case anyone wishes to build this tuner wtih its power supply attached, it would be a simple matter to allow a little more room on the chassis, preferably at the end away from the valves, where the power transformer and rectifier could be mounted. The smoothing choke could be accommodated under the chassis; the power supply circuit given in the high-quality tuner in last month's issue will be quite satisfactory as it stands for this one, or the 6.3 volts for the heaters, and the 25 ma. at 250 volts, can be filched from the main amplifier, if this has the capacity to spare. If the amplifier H.T. is 300 volts or over, it will be essential to use a voltage divider, to obtain the 250 volts, and on no account should be simple dropping resistor be used.

Unless the amplifier power transformer can supply 25 ma. for the tuner and, say, 20 ma. for the voltage divider, the cheapest and best solution will be the separate power supply for the tuner.

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Frequency Meter	Type 726	Phase Measuring Equipment	Type RX 103	Valve Voltmeter	Type 712
Frequency Standard	Type 761	Power Output Meter	Type 708	5 Kv Ionization Tester	Type 732
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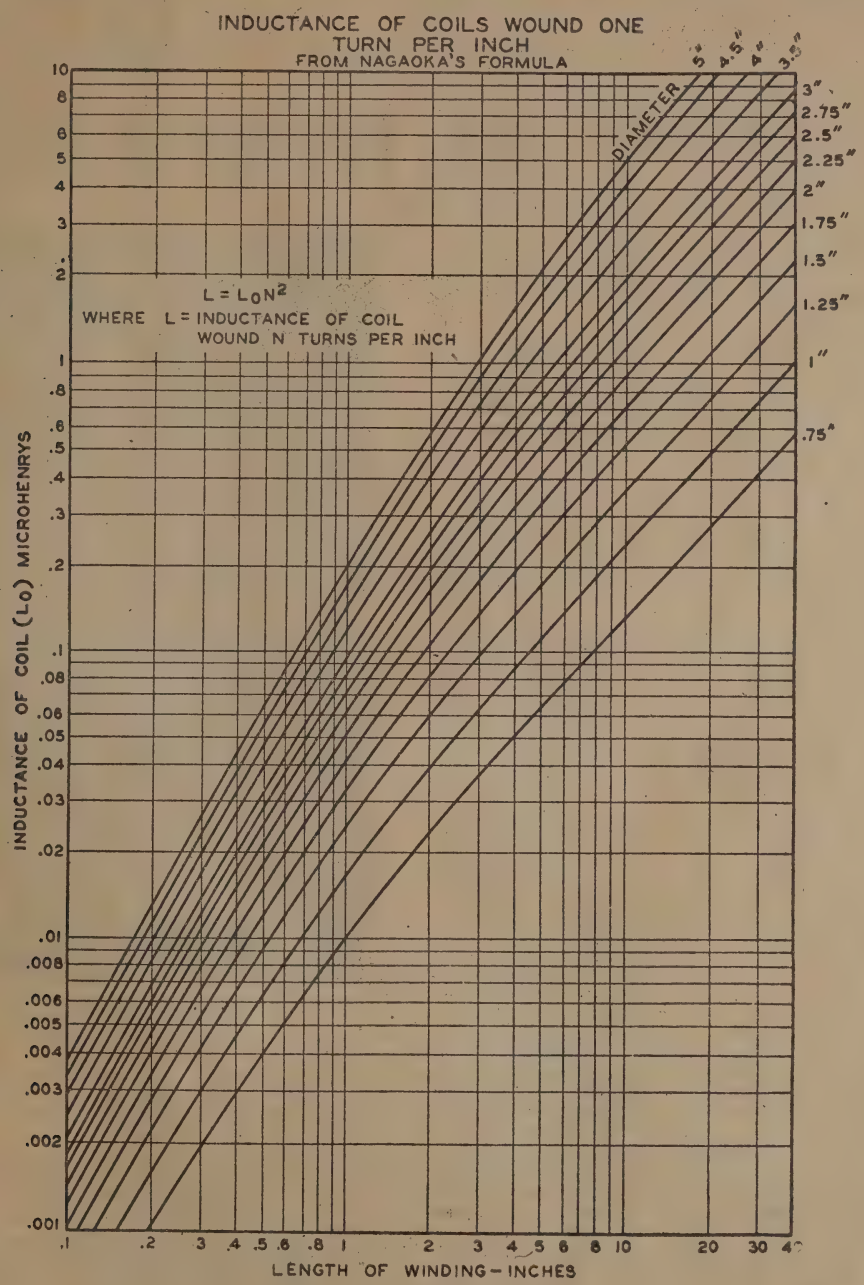
Design Sheet No. 12: Inductance of Single-layer Coils



While it is a relatively simple matter to decide, by the use of the formula or otherwise, what inductance is wanted for a given transmitting coil, it is not quite so easy to estimate how many turns, at what winding pitch, and on what diameter of former, are needed to give a coil of the calculated inductance. Various methods have been suggested for calculating the dimensions and number of turns of the coil, based on the original formula developed by the Japanese scientist Nagaoka, but few of these methods are of much practical use, mostly because they entail a certain amount of cut and try in addition to calculation. If we are to calculate our coils, then the answer must be accurate for practical purposes, otherwise the time and labour of the calculation is wasted.

The accompanying chart, originally published by Radio Corporation of America, represents a successful attempt to overcome these difficulties. A glance at the chart shows that it consists of a number of curves, each applicable to a particular winding diameter, so that once the former diameter has been chosen ,we work with only one of the curves, ignoring all the others. Along the X axis, we have a scale for the length of the winding, while the Y or vertical axis of the graph carries a scale for the inductance. This scale, it will be noted, goes from 0.001 microhenries to 10 microhenries. As noted at the top of the graph, it refers only to coils wound at a pitch of one turn to the inch. At first sight this may not appear very useful, since it is only very rarely that coils of this kind are used, but it is a very simple matter to make the graph applicable to any desired pitch of winding. For instance, suppose we want a coil of 1 inch diameter, and inductance 9 microhenries, and that we are going to wind the coil at a pitch of 10 turns to the inch. First of all we must convert the actual inductance L, of 9 μH, to a fictitious inductance L_o, by the formula: $L_o = L/N^2$, where N is the actual number of turns to the inch that we are going to use. In the case of our example, we have:—

$$L_o = L/100 = 0.09\ \mu H.$$

We now have a value for L_o, *which is the value of inductance to be used when working with the chart.* Thus, we have to find the length of winding on a 1 in. diameter former, that will give an inductance of 0.09 μH. This gives a winding length of four inches, according to the chart, so that the total number of turns will be $4 \times 10 = 40$. Had we decided on a winding pitch of 16 turns to the inch, L_o would have been reduced to 0.035 μH. Applying this to the chart we get a length of 1.8 in., so that the turns needed be would $1.8 \times 16 = 29$.

ANSWERING OTHER PROBLEMS

The chart can also be used to find the inductance of an existing coil, by working the process backwards. For instance, suppose we have a coil wound on a $\frac{3}{4}$ in. diameter former, with 50 turns occupying a winding space of 1 inch. The chart tells us that a coil wound at one turn to the inch, and a length of 1 inch has an inductance of 0.01 μH, when wound on a $\frac{3}{4}$ in. former. But our formula, slightly rearranged, says that:—

$$L = L_o . N^2.$$

L_o we have already found, and N is 50, as the dimensions of the coil show, so that the actual inductance of the coil is $50 \times 50 \times 0.01 = 25\ \mu H$.

Another problem is that of finding what gauge of wire to use to get the required inductance, if both the diameter and length of the winding are fixed. Suppose, for example, that we have a $1\frac{1}{2}$ in. former, and we require an inductance of 10 μH. For reasons outside our control, the winding must not be more than $1\frac{1}{2}$ in. long. We proceed as follows. This time, it is N, the number of turns per inch that we must find, so the formula is rearranged once more, to the form:—

$$N^2 = L/L_o.$$

The inductance L, we know to be 10 μH. The chart tells us that for a coil $1\frac{1}{2}$ in. in diameter, and $1\frac{1}{2}$ in. long, $L_o = 0.05\ \mu H$. Therefore, $N^2 = 10/0.05 = 200$. By finding the square root of 200, we find that N is 14.1 turns to the inch. We can now use the wire tables to find out the largest wire that will allow close winding, or we may choose a smaller size of wire, and wind it at the required pitch to occupy $1\frac{1}{2}$ in. of winding space that is available.

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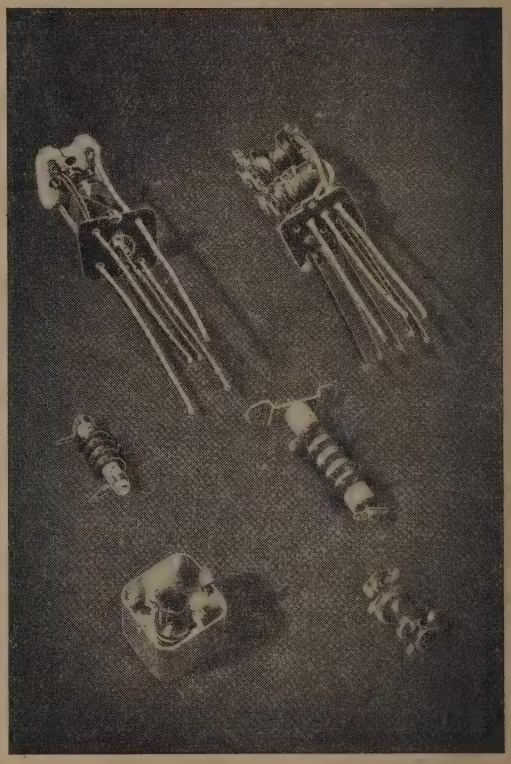

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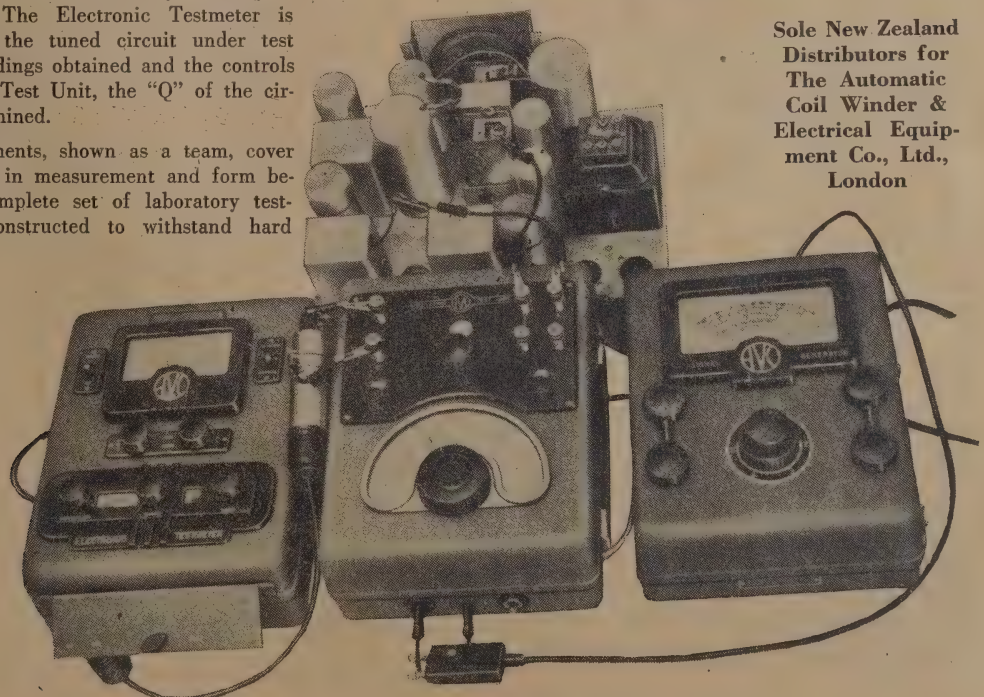


How the Image Orthicon Works

Those who were privileged to witness the recent demonstrations of wired television in Auckland and Wellington, will no doubt be interested to learn some of the details of the image orthicon camera tube which was used in the camera on those occasions. The subject of camera tubes is a very interesting, but complex one, and we have endeavoured to write a description that explains as simply as possible how this most modern tube works, and how it achieves its amazing sensitivity.

INTRODUCTION

Perhaps the most marvellous example of modern electronic technique is the latest type of television camera tube. Not only is it capable of generating electrical picture signals with extraordinary accuracy and detail, but it is able to do this with little more light than the human eye needs in order to see. It is thousands of times more sensitive than the most sensitive photographic film. So much so, in fact, that these television cameras are being used as a sort of light amplifier, in order to make possible photographs that could never be taken directly by a camera, however wide its lens. Because of the astounding performance of these electronic camera tubes, television technique is being used for a great number of purposes where the ability to transmit the picture over wires, or by wireless transmission, is only a secondary consideration. For instance, it is possible to produce on a cathode ray tube screen, greatly enlarged pictures of phenomena that cannot possibly be reproduced by purely optical means. An example of this is the televising of surgical operations. Here, the television camera can not only bring pictures of the operation to large numbers of viewers outside the operating theatre, at the same time that the operation is taking place, but it can give greatly enlarged images of, say, eye operations, so that the viewers can see as much, if not more, of what is going on, than the surgeon himself!

Again, the television camera is being used to produce enlarged images of phenomena taking place under the microscope—phenomena that would be quite impossible to enlarge by the usual optical projection methods. Thus it can be seen that the many applications of TV technique bid fair to outnumber by a long way the uses for which the television camera was originally designed.

PRINCIPLE OF OPERATION

Of course, the fundamental principle upon which all camera tubes work is the well known one of photo-emission. We who work with radio valves and circuits tend to forget that thermionic emission is not by any means the only process by which electrons can be liberated and made to do a useful job. The basis of the camera tube, in its fundamental simplicity, is the process whereby certain materials have the property of emitting electrons when struck by light. This is exactly what goes on inside the ordinary vacuum photo-cell that is used for so many purposes these days. The cathode is not heated to make it give up its electrons but is instead coated with one of the more active photo-emissive materials such as metallic potassium, rubidium, or caesium, or with a specially prepared composite material that has been developed for the same purpose. These photo-emissive materials not only emit electrons when struck by light, but have the useful property that the number of electrons emitted is directly proportional to the strength of the light, and it is this factor that makes them so very useful in converting light values to corresponding electric currents and potentials.

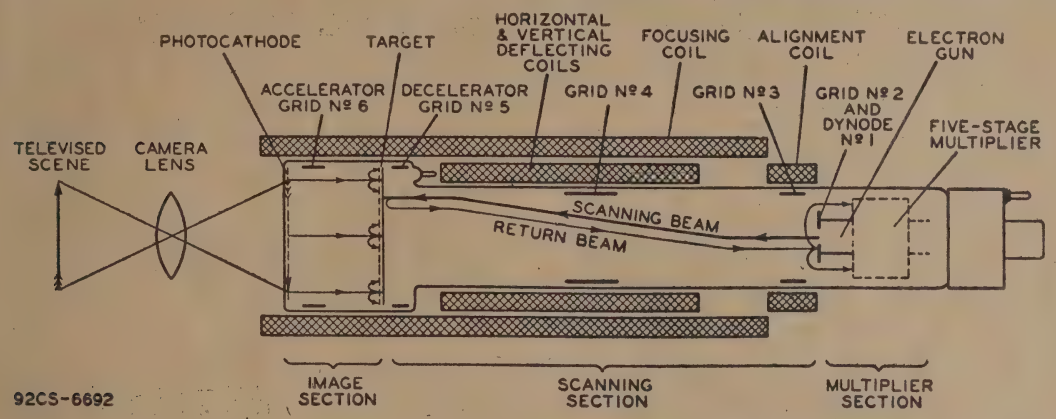
The front face of the image orthicon tube is made of very accurately flat glass, on the inside of which is an almost unbelievably thin coating of the photo-emissive material. This coating is so thin as to be almost invisible, and it is quite transparent to light. The first essential portion of the TV camera, however, is a lens, exactly equivalent to the lens of a conventional camera, which focuses the scene to be televised on the thin coating of photo-emissive material, which is known as the photo-cathode. This is an actual physical light image that is formed on the photo-cathode, and its intensity from place to place causes an exactly corresponding intensity of electron emission to occur. The photo-cathode, therefore, produces an electron image corresponding in density to the optical brightness of the image.

Round the edge of the tube, close to the photo-cathode, is a ring-shaped electrode, known as an accelerator, which is placed at a positive potential of approximately 100 volts with respect to the cathode. This produces a field which attracts the electrons emitted by the photo-cathode and causes them to travel down the tube away from the cathode. This they do without losing their spatial relationship with each other, and we can visualize the electron image as floating, in a sheet parallel with the cathode, down the tube until it comes to the target. This electrode is made of glass, but on the photo-cathode side of it there is a very fine mesh screen, spaced from it by only about a thousandth of an inch. The mesh is held at a potential of about one volt positive; when the electrons from the photo-cathode hit the glass screen (which they do by passing through the spaces in the mesh) they cause secondary electrons to be emitted by the glass, and these are immediately attracted to the slightly positive mesh, and are collected by it. The secondary electrons do *not* pass through the holes in the screen because (a) it is so close to the glass, and (b) because their velocity is so small, due to the low potential of the mesh, that they are unable to escape from its field of attraction, even when they set off to pass directly through one of the holes. This process leaves the glass target with a pattern of electrostatic charge on it, which is again a replica of the light pattern on the photo-cathode. Since the glass is an insulator (at least from a long-term point of view) this pattern of charges remains on it for the whole of one scanning period, by which time other things have happened, and the pattern made use of to form the signal current from the tube. To see how this comes about, we must have a look at the remainder of the tube.

At the end of the tube remote from the photo-cathode, there is an electron gun which produces a stream of low-velocity electrons. This beam is similar to the beam of a cathode ray tube, except that its velocity is much lower. It is focused electromagnetically by a long coil which occupies most of the length of the tube. The electron gun is a comparatively complex one with a control grid, an accelerating grid, and a focusing grid, and, together with the focusing and deflecting coils, arranges for the beam to be deflected in the rather unusual way illustrated in the figure. That is to say, the beam is

scanned over the glass target in such a way that it always lands *at right angles to the target*. This is important, because with a slow-moving electron beam scanning must be done in this way if the beam is to remain in focus, irrespective of where it is on the target. Incidentally, it is this question of a special deflection method that makes the tube very tricky to adjust. However, once the correct adjustment is found, it stays put quite well.

The target is scanned with the usual system of lines and frames, that is common to all camera tubes and to the receiving cathode ray tubes also. Now the important thing about the beam is that in traversing the target, which, it will be remembered, carries the picture on it as a pattern of positive charges, it becomes modulated. The extent of modulation at any instant is determined by the positive charge on that portion of the glass target which is being struck by the beam at that instant. The subsequent behaviour of the beam allows this modulation to be transferred to the external circuit as the output signal of the tube. Imagine for a moment that the beam is traversing an area of the target on which there is no positive charge. This area will, therefore, represent a part of the picture which has no light at all on it, for such a picture area would emit no electrons from the photo-cathode, so that there can have been no secondary electrons dislodged from the corresponding portion of the target, which is therefore uncharged. From such an area, therefore, the beam is simply reflected by the target without any change in the number of electrons on it, and therefore without any modulation having taken place. Now if the beam comes to a part of the target in which secondary emission has taken place, this part will have been left with a net positive charge, and some of the electrons from the beam will be collected by the target in its attempt to return to an uncharged state. Thus, the more light that strikes that part of the photo-cathode which is directly opposite the part of the target that is being scanned, the more highly positive will the corresponding part of the target have become, and the more electrons will be abstracted from the beam when this part is scanned. It is clear, therefore, that as the beam scans the target, the number of electrons in the *return beam* that is reflected from the target, is at all times proportional to the amount of light on each element of the target that has just been scanned. Therefore, if the return beam can be collected, it will constitute an electrical signal giving instantaneous information about the brightness of the original picture from moment to moment, at those parts of the picture that have just been scanned. The focusing coils and electrodes act on the return beam just as they did on the original outgoing beam, so that as the diagram indicates, the returning modulated beam returns along a very similar path to the one it took on its outward journey, and eventually lands up almost where it started from, at the gun end of the tube. Here, it is collected by the first dynode of a five-stage electron multiplier, the output of which is the signal output of the whole tube.



SOME SPECIAL FEATURES

The extremely high sensitivity of the image orthicon compared with other earlier camera tubes results from the method of operation. It will be remembered that the electron image formed by the photo-cathode is constantly accelerated towards the target, where it produces the charge image by inducing secondary emission from the glass of the latter. Now each part of the target is scanned by the electron beam only once every fiftieth of a second, so that each portion has a whole fiftieth of a second in which to build up its charge. The charge built up will depend not only on the intensity of the light on the corresponding part of the photo-cathode, but also on the length of time the target is acted upon by the primary electrons from the photo-cathode. This is known as the storage principle, because the target stores a charge that is built up over a comparatively long period. As soon as a particular part of the target has been scanned by the beam, the storage process starts, and the charge builds up until the scanning beam comes round again, one fiftieth of a second later.

As can be seen from the brief description we have given of the manner in which the image iconoscope works, it is a most complex piece of equipment, and one which is not at all easy to manufacture. For instance, since the charge pattern is produced on one side of the target, and the scanning beam impinges on the other side of it, it is essential that the glass of which the target is made have an accurately specified conductivity. If this is too small, permanent charges are built up on the glass, preventing the charge pattern from accurately representing the picture. If the conductivity is too high, the charge pattern leaks away before the scanning beam has been modulated by it, and the picture does not appear at all. Thus, one of the manufacturing problems is to ensure that the glass of the target has not only the correct thickness, but also the same conductivity at all points, the value of which must be accurately held within close limits. This is only one of the special problems involved in making such tubes. Another is the manu-

(Continued on Page 48.)

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For the P.A. Operator

A High-powered Public Address Amplifier

It is with pleasure that we feature this month the circuit of a high-powered amplifier capable of handling quite large public address jobs. It is straightforward in design and construction, and offers no difficulties to the experienced builder of audio equipment. The four 807s in the output stage are working under Class AB1 conditions, so that no power is called for from the driver stage, and it is possible to use the conventional split-load phase inverter. The amplifier proper comprises V_4 to V_9 inclusive, the remaining stages making up the pre-amplifier and electronic mixer circuits.

Two microphone inputs are provided for, together with one low-gain input for a gramophone pick-up. Isolating resistors following the gain controls eliminate possible cross-talk between channels, and ensure that each control effects only the channel it is intended to control.

A novel, and very worthwhile feature is the provision of direct current from the main H.T. supply for heating the pre-amplifier tubes. This eliminates at one swoop the possibility of heater-cathode hum, which is the bugbear of A.C. operated high-gain amplifiers. The three heaters, in series, are wired at the earth end of a heavy bleeder and voltage divider whose primary function it is to provide a steady, well-regulated screen voltage for the 807s. Intending builders would be very well advised not to alter this part of the circuit at all, for the performance of the amplifier is critically dependent upon it. Most of the trouble experienced in getting full output from beam tetrodes is due to poor regulation in the screen voltage supply. This method of obtaining the requisite voltage may seem expensive, in that it requires an extra 300 ma. from the main transformer. In reality, however, the extra expense is more apparent than real, because by having a substantial bleed on the main H.T. transformer, the regulation of the plate supply also is improved. The plate current swing for Class AB_1 operation of four 807s is rather large, and without a bleeder, some form of voltage regulation would be required if the full power output were to be realized. This would almost certainly turn out to be much more expensive than simply making the current capacity of the transformer large enough to cope with the bleeder current, and in addition, it would be much more complex, with a good deal more in it to go wrong. On balance, then, the method used here probably represents the best possible engineering practice, and should be an object lesson to those who have thought that the power supply is a necessary evil to be tacked on to a high-powered amplifier with as little thought as possible!

The circuit was designed by Mr. A. McD. Cooper, of Messrs. Green and Cooper, Ltd., and it is through his courtesy that we are able to present it to readers. Numerous examples of this amplifier are in service, and are giving excellent results, so that any P.A. operator who feels that this is the amplifier he has been looking for can build it with confidence that it will be thoroughly successful. Any inquires regarding the amplifier, or components for it should be addressed to the office of this journal rather than direct to Mr. Cooper.

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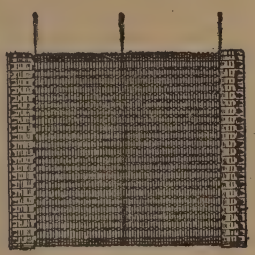

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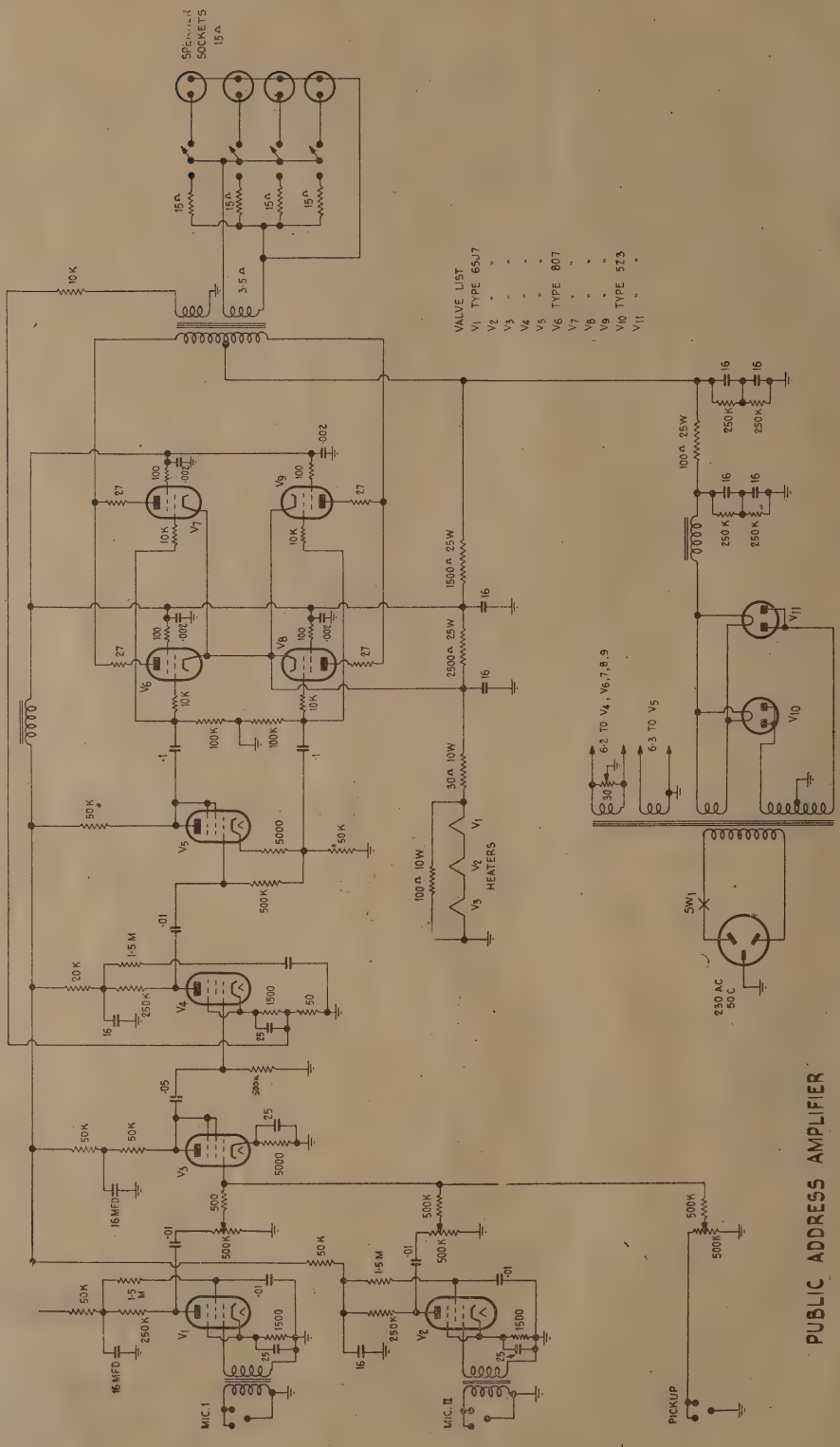
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V7 " "
V8 " "
V9 " "
V10 TYPE 5Z3
V11 " "
100Ω 25W
250K
1500Ω 25W
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Time Delay Circuits

By the Engineering Department, Aerovox Corporation

On numerous occasions it is required that a circuit shall be opened or closed automatically a definite time after an initiating impulse. Examples of such requirements are: The application of the plate voltage on a mercury-vapour rectifier tube after the filament has heated; the timing of arc-welding; automatic door openers; regulating photographic exposures, etc. This article will review the diverse ways wherein the desired effect can be accomplished and will show a method of calculating the required constants for a given delay.

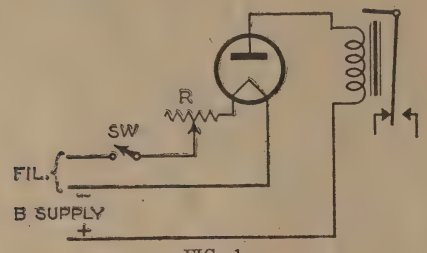

FIG. 1

According to the requirements one may distinguish between the following cases: A circuit must be opened a definite predetermined time after an initiating impulse, it has to be closed, or it has to be first closed and then opened, both events to occur after separately controllable time delays. Finally, there is the case where the previous cycle must be constantly repeated.

According to the methods employed, time-delay devices may be mechanical, thermal, or depending on the discharge or charge of a condenser in conjunction with electron tubes. There can also be combinations of these.

The mechanical arrangements involve relays with plungers or electric clock mechanisms which are already well known and need not be considered here. Among the thermal methods, attention is called to the utilization of the heating time of vacuum tubes. In Fig. 1 a simple circuit is shown embodying this principle. When the switch SW is closed, the tube filament begins to warm up and the plate current rises gradually until the relay pulls up and either opens or closes the load circuit. The time can be regulated between reasonable limits by adjusting the relay or by inserting resistance in series with the filament and raising the applied voltage accordingly. During the heating-up period, the cold filament has lower resistance, so when it is in series with an unvarying resistance it will receive only a small part of its share of heating power, thereby increasing the time. Still further delays can be obtained by employing an indirectly heated tube, but then sufficient time must be allowed for the cathode to cool before the device is used again. In other systems a bi-metallic strip is more or less slowly heated until it closes the load circuit.

CONDENSER CHARGE OR DISCHARGE METHODS

It may take considerable time to charge or discharge a condenser through high resistance. This phenomenon can be utilized if the voltage across the condenser is used to control a switch by means of a tube and relay. In most cases there are several possible solutions, some involving a charge and some a discharge of a condenser.

Consider Fig. 2; when the switch SW is closed, plate current will immediately flow because the tube is heated all the time and the initial charge of the condenser is zero, making the grid bias equal to the voltage drop across R_2. The relay therefore pulls up immediately and closes the circuit. The condenser

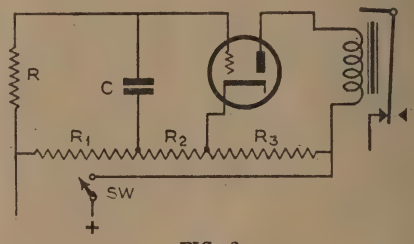

FIG. 2

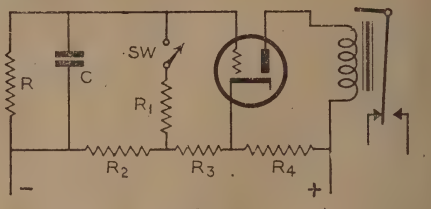

FIG. 3

meanwhile charges slowly through R and the plate current gradually decreases. When it reaches the critical point, the relay drops out. The circuit will then be ready for action again after SW is opened and the condenser is discharged. If desired, all these reset operations can be performed automatically by employing a relay with multiple contacts.

A second method to accomplish the same result is shown in Fig. 3. While the switch SW is closed, the condenser is charged through R_1, which is a low resistance. This brings the grid bias down to the voltage drop across R_2, which is a safeguard to prevent overloading of the tube. The relay pulls up when the switch is closed. After the switch is opened, the condenser discharges through R, making the grid more and more negative until the relay falls back. The circuit is ready again when the switch is closed for a short period.

When it is required to CLOSE the load circuit after a delay, it could simply be done by using the back contacts of the relays in Figs. 2 and 3, but the circuit can also be rearranged. So, for instance, in Fig. 4 the grid starts out with a very negative bias when SW is set at A. When the condenser is nearly charged, the bias becomes low enough to permit plate current to flow in sufficient amount and the relay closes. Resetting is accomplished by throwing the switch SW to the discharge position, B, when C discharges through R_4.

In Fig. 5 the condenser is first charged to the full B-voltage and then connected to the grid so as to make it negative when the switch is thrown. The condenser again discharges through R until the bias has become low enough to trip the delay.

There are numerous other combinations to obtain the desired effects, and before proceeding to describe involved circuits it is desirable to examine the foregoing more closely.

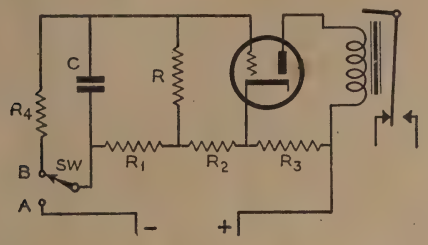

FIG. 4

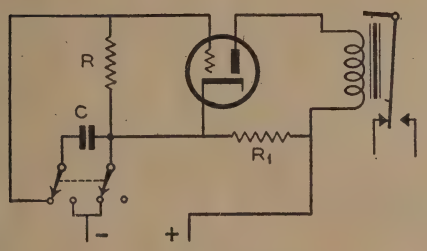

FIG. 5

It is essential that D.C. be employed for the B-supply, although the filaments or heaters may be supplied by A.C. Therefore, any conventional power supply will do, and voltage dividers can be employed as shown. However, it is desirable that the voltage drop across R_1 be large in all cases and that it does not vary with the plate current in the tube if the time delay is to agree with calculations. In such cases it is often best to employ two separate power supplies which are independent, one to supply the plate of the tube, the other to charge the condenser. This is done most conveniently by means of voltage doubling. Fig. 6 shows how Fig. 3 may be modified in this manner.

CALCULATING THE TIME

The time of the delay is a function of C, R, and the ratio e/E where e is the voltage across the condenser which causes the relay to operate, and E is the voltage across the condenser when fully charged.

When a condenser charges through a resistor the voltage across it increases according to the curve A in Fig. 6a; it can be mathematically expressed by the equation

$$e = E\left(1 - \epsilon^{-\frac{t}{RC}}\right)$$

From this equation it is easily seen that when $t = RC$, the exponent becomes -1 and e becomes 63 per cent. of E. Similarly, if $t = 3RC$, e is 95 per cent. of E. This product RC is called the time constant of the CR circuit.

In the case of discharge, the condenser voltage falls according to the curve B. This one is a graph of the function

$$e = E \cdot \epsilon^{-\frac{t}{RC}}$$

If $t = RC$, the exponent again is -1 and the condenser is discharged to 37 per cent. of its original charge. It should be clear that the time elapsed to

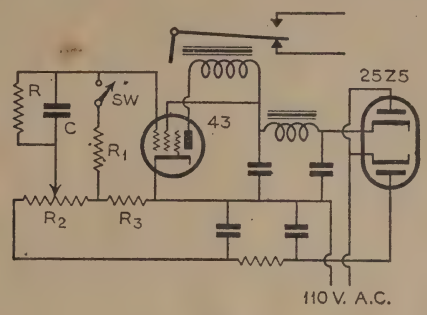

FIG. 6

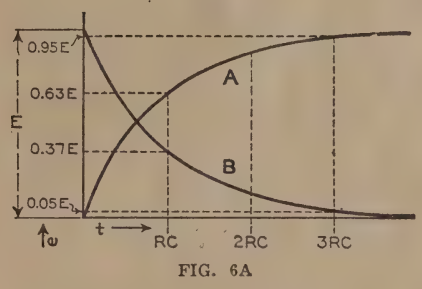

FIG. 6A

reach a given voltage in all cases depends on R and C as well as the charging voltage.

Expressing C in microfarads and R in megohms, the time delay is given by the following equations:—

For charge:

$$t = RC \log_e \left(\frac{E - e}{e}\right)$$

For discharge:

$$t = RC \log_e \left(\frac{e}{E}\right)$$

There are several possible ways of arriving at the required constants for a given time delay. In Fig. 7 the chart shows the time in seconds plotted against the ratio $(E - e)/E$ or e/E for different values of RC. An example will clarify its use. Suppose, in Fig. 4 the total power supply is 250 volts D.C. across R_1, R_2, R_3, the voltage across R_2 is 10 volts, and the relay is so adjusted that it will operate when the grid bias is 15 volts. If the voltage drop across R_1 is 100 volts, the critical value e is 95 volts and $(E - e)/E$ is 0.05. In order to obtain a delay of, say, 12 seconds, find the point corresponding to $(E - e)/E = 0.05$ and $t = 12$ in Fig. 7. This point is located on the line $RC = 4$. Thus a 4 μf. condenser and a 1 megohm resistor, etc.

In general, the point will not be found exactly on one of the RC lines, and interpolation may be neces-

sary. If this is found difficult, find the corresponding time when RC is unity, then divide this time into the required time to find the value of RC.

The range of the chart may be extended by multiplying all values of t by any convenient factor.

In the above illustration one must be sure to take into consideration the bias on the tube provided by R_2. Also, the required grid bias must be determined from the dynamic characteristic for a load equal to the relay resistance.

The entire calculation can also be done conveniently on a log-log slide rule. If all values but t are known, set RC on scale B to 1 (centre) on scale A. Opposite (E — e)/E or e/E on scale LLO, find t on B. The same procedure is also followed when RC and t are given. If RC is to be found, set t on B to (E — e/E or e/E on LLO). Then find RC on B opposite 1 on A.

PRACTICAL LIMITATIONS

The methods of calculations are correct only when one deals with a condenser having very low leakage, and provided that there are no other conditions in the circuit which modify the critical constants. So, for instance, when R is several megohms there should not be any appreciable leakage in the mounting of the parts and the input resistance of the tube should be high.

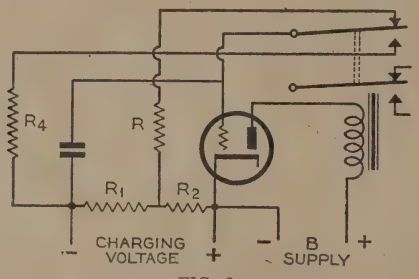

FIG. 8

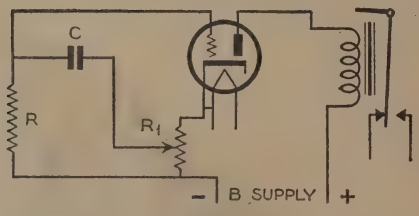

FIG. 9

These factors become of great importance when long time delays are required. In such cases a large condenser will probably be required. The leakage resistance of a paper condenser is inversely proportional to the capacity. With a new high-grade condenser, the product of microfarads and megohms might be above 2,000. The leakage resistance to be expected can be estimated from this figure. However, this does not include possible leakage over the outside surface of the condenser. This outside leakage depends on the length of the path between terminals and the humidity. The length of the path between terminals does not necessarily vary in proportion to the capacity. When the resistance of this path becomes comparable to R, the time delay will be subject to erratic variations. In general, the leakage resistance should be at least 50 times the charge or discharge resistance, R.

The next unit of importance is the resistance, R. When this is a very high resistance of the grid leak type, enclosed in a glass tube, the condition of the glass becomes important. Dust and dirt collecting on the glass may offer a leakage path of less resistance than the resistor itself. The condition can be remedied by dipping the glass in paraffin wax.

The tube may represent another problem; when power tubes are used in parallel with high-resistance grid leaks, the effective resistance of the two in combination may be considerably reduced due to gas current. Therefore, if the resistance of R is 5 megohms or more, it is necessary to make a careful choice between possible tubes.

ADDITIONAL CIRCUITS

If it is desired to have a device which keeps on opening and closing the load circuit, it can easily be made by a slight modification of Fig. 4. If the switch SW is one of the sets of contacts on the relay while it is used to connect C either to the charging resistor R or to the discharge resistor R_4, the requirements are fulfilled. The circuit then becomes as in Fig. 8. In the position shown, the condenser is charging through R. When the charge is high enough to make sufficient plate current flow, the relay pulls up and starts the discharge through R_4.

Another type of circuit is shown in Fig. 9; this is due to Gulliksen and described in "Electrical

(Continued on page 48.)

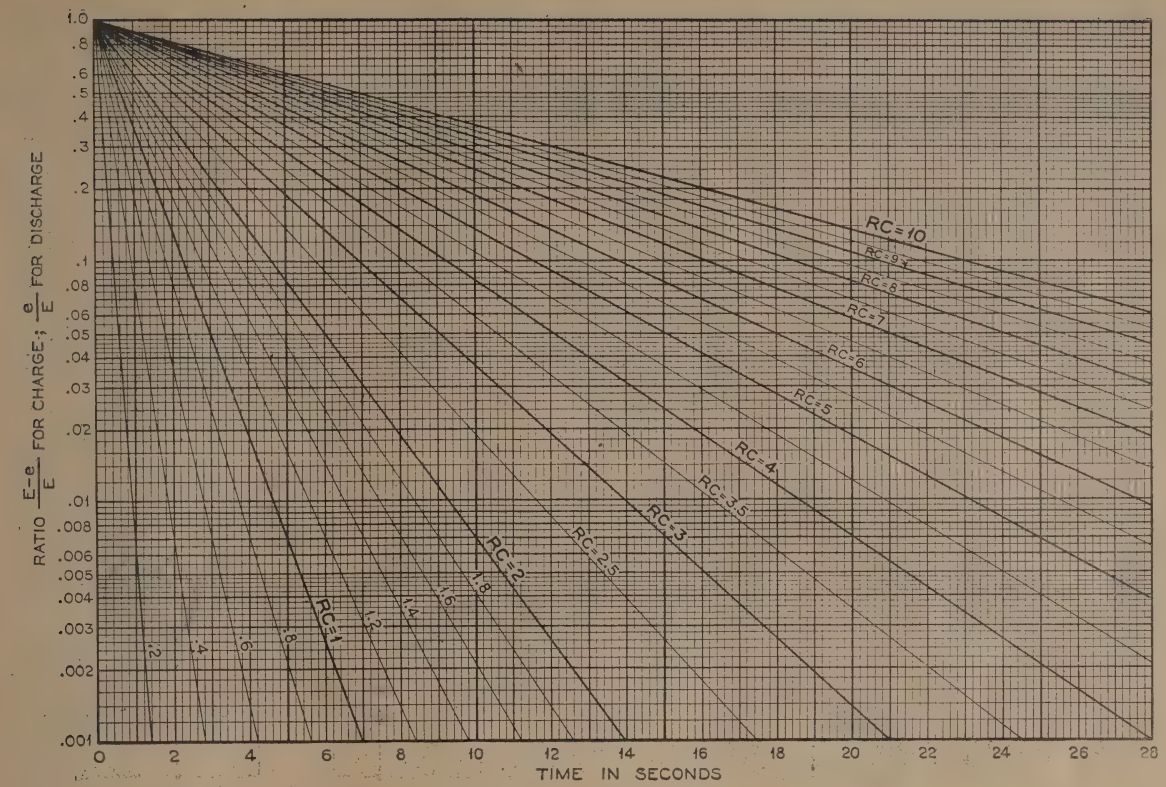

FIG. 7

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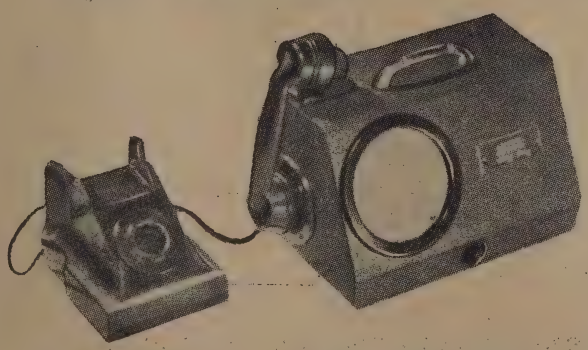

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"The time has come," the Walrus said,
"To talk of many things. . . ."

By Special Arrangement with the Walrus

A problem encountered recently during the daily business grind concerned a client who had some twelve months previously purchased an amplifier and now required some means of running a microphone at a distance from the amplifier while still being able to control the level of sound output from a position near the mike. Obviously this meant a pre-amplifier with a low impedance output feeding into the main unit, which, just to complicate matters, had no low impedance input. Now, as all the good textbooks on radio will tell you, this is the very job for transformers which seemingly just love to step impedances up or down with such gusto that one immediately suspects a catch somewhere. Well the catch is there alright, for what the textbooks omit to mention is the fun you will have positioning input transformers on a chassis carrying a power supply. That it can be done there is no doubt, but the problems encountered are such that if an alternative method of doing the job presents itself then it should be fully explored for possible merit, and in this case an alternative method was available in the shape of a cathode

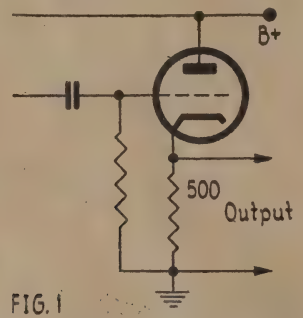


FIG. 1

follower. Most radiomen who had any radar experience in the Services will be familiar with this useful fellow and will very likely have found many way of employing it. For the particular problem under consideration, however, it is just the answer. It consists simply of a valve with the signal fed to the grid in the normal way. The plate, however, is connected directly to high tension positive without an anode resistance and the cathode resistor is employed as the output load. The cathode follower thus has the value of a very high input impedance and a low output impedance. A simple arrangement is shown in the accompanying diagram.

Proceeding a step further with our pre-amplifier, it is necessary to provide a high-gain valve ahead of the cathode follower in order to get sufficient driving voltage and thus allow room for a gain control. This is easy enough to arrange and a suitable circuit showing a pre-amplifier and cathode follower with a gain control is shown in Fig. 2.

The resistor in the cathode of the cathode follower may be any low value about the 500-ohm mark and may be varied depending upon the amount of output voltage required. At about this stage is the cue for the workshop bright boy to pose the obvious question: "If you've only got a high impedance input for a microphone or pick-up on your amplifier how are you going to feed it from a remote pre-amplifier with a low impedance output!" Well, we had been expecting this one and had the answer ready—you just feed it in regardless and damp the amplifier input down to a very low level. It makes no difference if one damps a grid circuit down to just a few ohms for provided you have sufficient driving voltage available the valve will amplify just as well as ever.

In the case under consideration the pre-amplifier was fed into the record input of the main amplifier and the

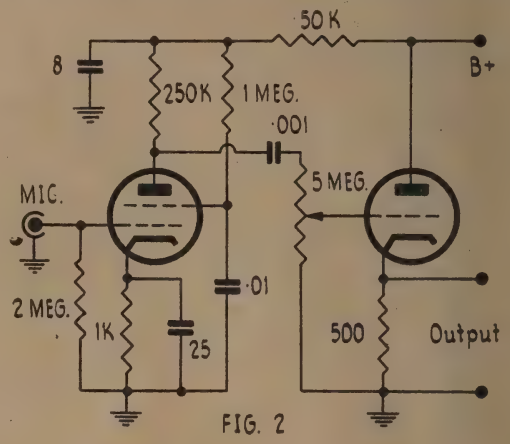


FIG. 2

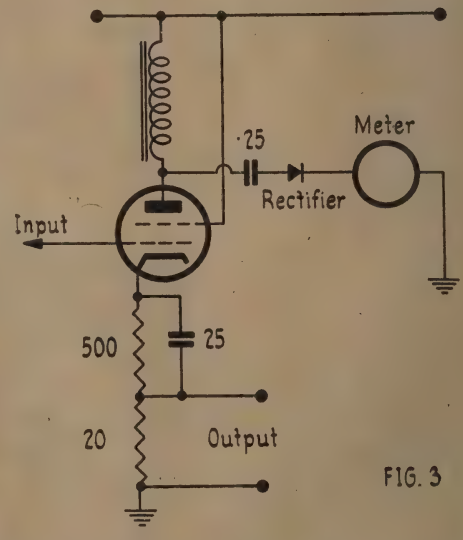
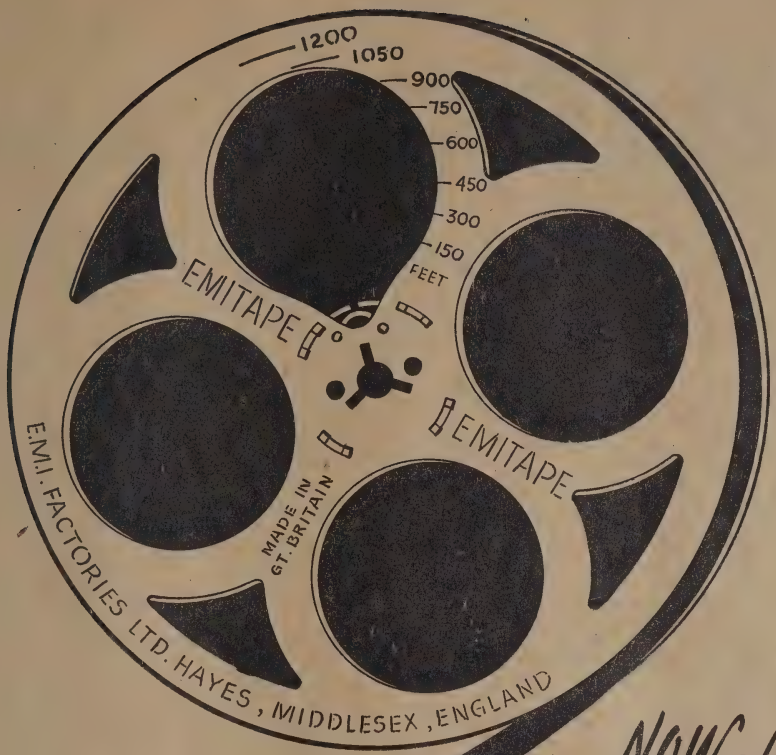


FIG. 3

record gain control was opened right up. The pre-amplifier gain control was then turned up about half-way and the cathode resistor of the cathode follower adjusted to give a good level of sound output. If the resistor finishes up at a lower value than first anticipated it does not matter and, in fact, will probably be an advantage. There is nothing magical in the figure of

(Continued on page 48.)



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No. 46: An Interesting Method Of Obtaining Very High Voltages—Part II

In order to transform what is so far merely a useful idea into a practical high-voltage power supply, not a great deal has to be done to the fundamental circuit of Fig. 1. A simple practical circuit is given in Fig. 3. Here, we have a Philips EN31 thyratron, used as a conventional saw-tooth generator. The EN31 is biased negatively by means of a fixed positive voltage on its cathode. This is provided by the bleeder of 120k. and 1500 ohms across the H.T. supply. The grid is returned directly to earth, since we do not have to inject a synchronizing voltage, the saw-tooth generator being free-running. The purpose of the 20k. resistor is to limit grid current, which will take place even though a positive synch. voltage is not applied to the grid. In series with the plate is a 1500-ohm resistor, at the upper end of which is connected a 500 $\mu\mu$f. condenser. This is the one which is charged and discharged by the thyratron in order to produce the saw-tooth, and the purpose of the 1500-ohm resistor is to limit the peak plate current of the thyratron to a safe value. At the start of the discharge, when the tube has just struck, the current can be very high indeed, and a limiting resistor as shown, sees to it that the peak plate current is not greater than the tube can stand without damage. The variable resistor R allows the frequency of the saw-tooth to be changed to suit the conditions obtaining in the rest of the circuit. Depending on the exact characteristics of the plate coil of the EL38, so will there be an optimum saw-tooth frequency, which will give maximum output voltage. Having the saw-tooth frequency variable enables this optimum frequency to be found, and also provides a simple control over the output voltage actually obtained. The saw-tooth is fed through the 0.01 μf. coupling condenser to the grid of the Philips EL38 pulsing tube. This valve is provided with cathode bias, which, contrary to expectations, was found to be quite satisfactory. It enables a rather smaller saw-tooth voltage to be used at the grid for the same output voltage, at the expense only of a little higher plate current in the EL38. In Fig. 3, an arrangement suitable for a negative output voltage is shown. The Philips EY51 miniature high-voltage rectifier is used in the well-known shunt circuit. This is very convenient, because it allows the heater of the rectifier to be grounded, and therefore to be run from the same winding as the other valves' heaters. Only a small coupling condenser is required, since the operating frequency is so high; this is helpful, too, because this condenser has to withstand the full peak voltage output of the pulsing tube, and its cost will be quite reasonable, in spite of the high voltage rating, because of its small capacity.

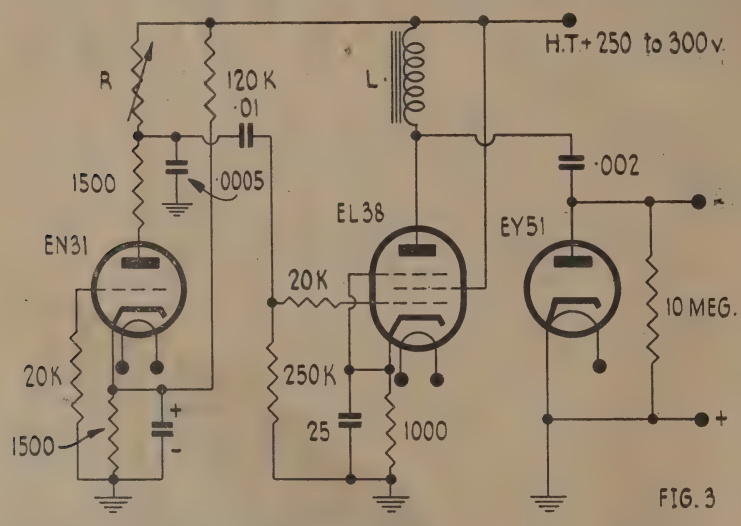

FIG. 3

Two other practical rectifier circuits are shown in Figs. 4 and 5. In the former, the series diode circuit is used. This necessitates a filament winding for the EY51, designed to withstand the peak voltage, and this is most easily provided by adding a small winding, transformer-wise, to the plate choke of the EL38. The disadvantage of this arrangement, however, is that it is no longer possible to make the output voltage adjustable, since this would also vary the voltage applied to the heater of the rectifier. For a fixed output voltage, however, there is no disadvantage of this kind. Filter condensers of 0.001 μf. will be found more than adequate in this circuit, and also in that of Fig. 5, which is the series rectifier circuit rearranged to give a positive output.

There is an important practical difference between the circuits of Fig. 4 and Fig. 5. It is that in the former, the rectifier heater winding is directly connected to the high-potential end of the main winding. In this case, therefore, no insulation is needed between the two windings. The heater winding can simply be a few turns at the high end of the main winding, the only insulation needed being that between the high-voltage winding and the core. In Fig. 5, however, the rectifier filament winding must be insulated for the peak output voltage of the pulse tube, not only between itself and the core, but between itself and the H.T. winding.

THE PULSE COIL, L

The heart of the whole system is the pulse coil, L on the circuit diagram. This can be made up by the builder, very simply and easily, if he uses another Philips product, namely a Ferroxcube core. These cores are supplied as solid E sections. That is to say, the material is not laminated, and, in common with all composite synthetic magnetic materials, is used in the block. Lamina-

tion is quite unnecessary, because the infinitesimal grains of magnetic material are insulated from each other by the binding material used to form the magnetic dust into a moulding. Because of this, eddy current losses are almost completely eliminated, while the user has the great advantage of not having to handle laminations. The cores referred to may be purchased, complete with a fibre bobbin, and all the hardware needed to hold the complete assembly together. All that has to be done in order to make up the choke is to put on the winding, as specified below, and then assemble the core, the two halves of which are held together by special clips provided for the

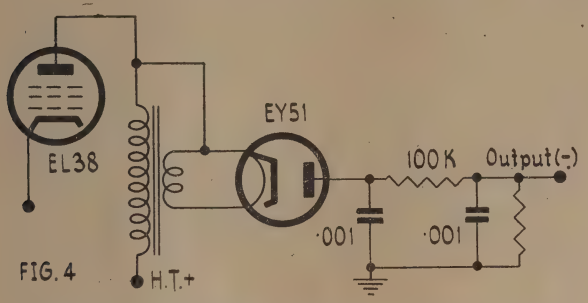

FIG. 4

purpose. The assembled core measures only 1¾ in. x 1⅝ in. x ⅜ in., and with the winding and core assembled, the outside dimensions are 2 in. x 1⅝ in. x 1⅛ in. It can be seen, therefore, that the system we have been describing is not only economical from the monetary point of view, but in space also. Provided with the core and bobbin, etc., is a brass case into which the completed choke can be slid, terminals attached, and the base soldered on. This base is tinned all over, and is provided with holes, specially shaped to take the modern small ceramic-insulated feed-through insulators that are standard terminations for the latest styles of transformers. The brass can is seamless, so that it is possible to fill it with oil after the coil has been inserted. One of the terminal holes can be left as a filling vent, and soldered over after the oil has been put in. If it is intended to put the choke in the can (though this is by no means essential) it would be advisable to oil-fill it. The whole thing is very compact, and arcing may occur in the confined space of the can if it is not filled.

The winding consists of 500 turns of 26-gauge enamelled wire. This is put on in layers, with a layer of 0.003 in. alkathene sheet over each layer of wire. It will be found that the bobbin takes approximately 60 turns of wire, so that a little over eight layers will be needed. The number of turns is not critical, and the ninth layer can be completed if desired. After the whole winding has been put on, as many layers of the alkathene sheet as will go on are put over the outside, so as to make the best possible insulation between the outside layer of wire and the core. If an output voltage of approximately 8000 is used, this means that approximately 1000 volts is developed between the beginning and end of each layer, and a voltage of twice this between adjacent ends of each two layers. The insulation required between the bottom layer and the core is not very great, because the high end of the bottom layer is only 1000 volts with respect to the core.

An interesting point is that with this winding developing 8000 volts, the output is measured in volts per turn, rather than in turns per volt! There is a practical point here, however, in that the voltage between adjacent turns of the winding is much greater than in conventional chokes or transformers, being twice the figure for peak volts per turn, or approximately 32 volts when the choke is developing a peak of 8000 volts. It might at first seem impossible to put on a secondary winding that would give only 6.3 volts output for the heater winding for the rectifier, but in this connection it should be remembered that the figures we have been quoting are peak voltages, and in terms of R.M.S., which is what counts when it comes to heating a filament, the figures get back to something more ordinary, and several turns are needed in order to provide 6.3 volts R.M.S.

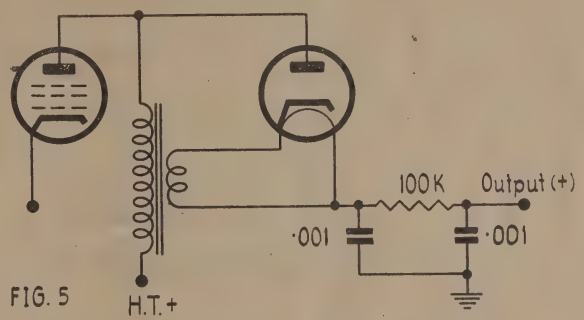

FIG. 5

HOW TO ADD A FILAMENT WINDING

With the extremely irregular kind of alternating current that we are dealing with, it is not possible by any means whatever to measure the effective voltage, so that special means have to be resorted to in cases where a filament winding is to be put on. The trick is to have two EY51s. A temporary winding of, say, 10 turns is put on the choke, and connected to the heater terminals of one of them. The other is connected across a 6.3-volt A.C. source. The pulse circuit is turned on, and the temperature of the two filaments is compared by judging which is the brighter. The winding is then adjusted by trial until both tubes light with the same brightness.

SOME FINAL POINTS

The value of the frequency control resistor R on the diagram can be fixed once the desired operating frequency has been found. For experimental purposes, it is best to make R from a 500k. potentiometer with a 500k. fixed resistor in series to limit the range of adjustment.

The inductance of the choke, as wound according to the instructions above, is approximately 0.5 Henries, and its distributed capacity is approximately 50 $\mu\mu$f. This makes the "ringing" oscillation take place at about 30 kc/sec. With the experimental set-up in the laboratory, it was found that the greatest output was provided by a saw-tooth frequency of 6000 c/sec., but that good operation was obtained over a range from 2000 c/sec. to 6000.

If a supply built along these lines is to be used for the E.H.T. supply of a cathode ray tube, it should be remembered that, unlike the ordinary transformer-rectifier system worked from the mains, unlimited power is not available. That is to say, the voltage divider for supplying the various voltages to the cathode, grid, and focusing anode should have a much higher resistance than usual. A recommended value for the total bleed on the supply is between 100 and 200 μamps., and if no more current than this is drawn off, the regulation of the supply will be quite good, and there will not be a large drop in output voltage compared with the open-circuit output. With the circuit of Fig. 3, no additional smoothing should be needed, and the 10-meg. bleeder resistor shown can be split up to make the voltage divider for getting the various electrode voltages.

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—*Wireless World* (Eng.), May, 1951, p. 168.

AUDIO EQUIPMENT AND DESIGN

There are four general parameters that influence the performance of loudspeaker cabinets—internal acoustical impedance, damping of the interior of the cabinet, mounting of the loudspeaker, and the shape of the cabinet. A design of a preferred cabinet is given with dimensions for the builder.

—*Radio and Television News* (U.S.A.), May, 1951, p. 54.

The ordinary amplifier is not suitable for magnetic recording unless specially adapted. Possibly the most efficient way to effect a flat response is to pre-emphasize the high frequencies and post-emphasize the high frequencies. An appropriate adapter for this purpose is described.

—*Ibid*, p. 64.

A system known an extended Class A amplification is described. The paper concerns a method of combining the familiar advantages of both triodes and tetrodes to extend Class A amplification to peak power only achieved in Class A-B or B, using 807s in parallel formation.

—*Electronics* (U.S.A.), May, 1951, p. 101.

A new professional tape recorder described for broadcasting station use. The machine incorporates the latest features such as accurate timing, low wow and flutter, plus quick starting.

—*Audio Engineering* (Eng.), April, 1951, p. 2.

Loudspeaker damping—a discussion of theoretical considerations of loudspeaker characteristics, together with a practical method of determining the constants of the unit as a preliminary step in obtaining satisfactory performance.

—*Ibid*, p. 24.

ELECTRONIC DEVICES

Resistance welding techniques provide a new tool for joining metals swiftly without using solders. It involves joining two or more pieces of metal by passing a high current through them. The control of the current is not easy, and a new method of electronic control is described.

—*Radio and Television News* (U.S.A.), May, 1951, p. 53.

Voice control of transmitters has long been used but a satisfactory and simple device for such a purpose is not easy to design. A full description of the voice operated switching is given which provides robot control of the transmitter.

—*Ibid*, p. 57.

The possibility of storing information on magnetic material is well known and used in the tape recorder. Binary information can be stored and read out in a magnetic medium statistically by electric pulses only. In such a system binary digits are stored in magnetic cores as residual magnetism, and a series of such cores connected so that the digits can be fed in at one end. Advancing pulses advance the digits to the counting device.

—*Proceedings of the I.R.E.* (April), 1951, p. 104.

MEASURING INSTRUMENTS AND TEST GEAR

A 7-band test oscillator is described with a range of frequencies from about 80 kc/sec. to over 100 mc/sec. Full building details are supplied with particulars of mounting the components.

—*Radio and Hobbies* (Aust.), June, 1951, p. 60.

A technique is described for testing video amplifiers with a square-wave generator which will determine immediately how the amplifiers are working. Methods are given of trouble-shooting with diagrams of the oscilloscope images and associated troubles.

—*Radio and Television News* (U.S.A.), May, 1951, p. 67.

Proper protection of electronic equipment demands that part of the apparatus shall be "grounded" and methods are given for measuring the efficacy of the ground by resistance tests.

—*QST* (U.S.A.), May, 1951, p. 23.

The usual instrument for detecting the balance point in bridges and other null systems of measurement is a pair of phones, but with these it is not always possible the detect the null point. The positive null detector described will detect amplitude variations down to 10 microvolts.

—*Wireless World* (Eng.), May, 1951, p. 175.

MATHEMATICS

In multivibrator and like circuits there is a transition from one stable state to another but there is a time-lag invariably involved. The paper shows how the speed of transition depends on the circuit parameters.

—*Wireless Engineer* (Eng.), April, 1951, p. 101.

In the design of resistance-coupled triode voltage amplifiers there is a combination of plate load resistance and the operating point which results in maximum output voltage. The estimation of the parameters is contained in a few simple equations.

—*Proceedings of the I.R.E.* (U.S.A.), April, 1951, p. 433.

The decibel—its definition and how it is used as a convenient tool by the design engineer to calculate gains and losses in audio equipment.

—*Radio and Television News* (U.S.A.), May, 1951, p. 60.

MATERIALS, VALVES, AND SUBSIDIARY TECHNIQUES

Travelling wave tubes with dispersive helices are under study. This type of tube consists of a helical wire in which the signal propagates at about a tenth of the speed of light. By velocity modulation and bunching, amplification results.

—*Wireless Engineer* (Eng.), April, 1951, p. 111.

Voltage controlled secondary emission multipliers. One of the difficulties with this type of valve has been its brief span of life which can be overcome by employing a layer of caesium oxide. The paper deals also with secondary emission variable mu valves, amplifying valves and the use of nets of dynodes. The estimation of characteristics is referred to.

—*Ibid*, p. 121.

Minimum cost transformers and chokes—a very full treatise on price in relation to the functions of those components which may be of considerable value to those designing them for commercial use.

—*Philips Research Reports* (Holland), October, 1950, p. 357.

A controllable gas diode the "plasmatron" is described, a hot cathode helium filled diode capable of controlling large currents at low voltages. The control operates at the valve's "Plasma" or region of equal densities of free electrons and positive ions.

—*Electronics* (U.S.A.), May, 1951, p. 107.

Varistors, circuit elements whose resistance is a function of the voltage applied, represent an important commercial application of semi-conductors. The paper deals with symmetrical and non-symmetrical varistors and the mathematics involved in their use.

—*Proceedings of the I.R.E.* (U.S.A.), April, 1951, p. 342.

PROPAGATION AND MODULATION

A really simple outline of frequency modulation for the beginner. Divorced from vector diagrams and mathematics the article gives tuition in a manner which can be appreciated visually from the graphs.

—*Wireless World* (Eng.), May, 1951, p. 193.

Straight amplitude modulation is rather inefficient, whilst single side-band suppressed carrier requires considerable knowledge and skill to operate successfully. Meantime there is an intermediate step—double side-band reduced carried which is a form of over-modulation without splather.

RECEIVERS

There is a maximum depth of modulation which can be allowed in the signal applied to a diode detector if distortion is to be avoided, and this depth depends on the ratio of A.C. to D.C. loads. Notes are given on circuit parameters for the satisfactory performance of diode detectors.

—*Wireless World* (Eng.), May, 1951, p. 171.

TRANSMITTERS AND TRANSMITTING

A coaxial tank amplifier for 220 and 420 mc/sec. transmitter is designed. The valve is a beam tetrode 4X150A, especially designed for V.H.F. work The coaxial tank circuit is very interesting and with the valve provides very high power for radiation.

—*QST* (U.S.A.), May, 1951, p. 39.

The Civilian Defence Stations of the U.S.A. have now had frequency band allocations and descriptions of various types of tranceivers are appearing. Amongst these is a super-regenerative receiver and low-powered transmitter herin described suitable for the 5-mile ranges.

—*Radio and Television News* (U.S.A.), May, 1951, p. 42.

TELEVISION

Recent release of manufacturing information to tube licensees in the U.S.A. gives details of the internal structure of TV tubes. Three electron guns are provided and the screen of a very intricate design for colour reproduction.

—*Electronics* (U.S.A.), May, 1951, p. 87.

MISCELLANEOUS

The uses of ultra-sonic energy are becoming wider and wider, from the washing of clothes to the production of alloys. A high-power generator is described and the methods in which energy is applied to the medium.

—*Radio and Hobbies* (Aust.), June, 1951, p. 17.

Brief notes are given on modern methods of calculating the speed of light. The most accurate figure available is probably 299,790 km/s and the interesting fact is the refinement of the methods.

—*Wireless Engineer* (Eng.), April, 1951, p. 99.

Many will be interested in the simplified Q multiplier. Multiplication of Q is on the principle of restoring to the tuned circuit the energy dissipated in its resistance. The use of such active networks is a practical way of raising Q and positive feedback around a vacuum tube amplifier is the natural development. A circuit is given with notes on the question of stability.

—*Electronics* (U.S.A.), May, 1951, p. 130.

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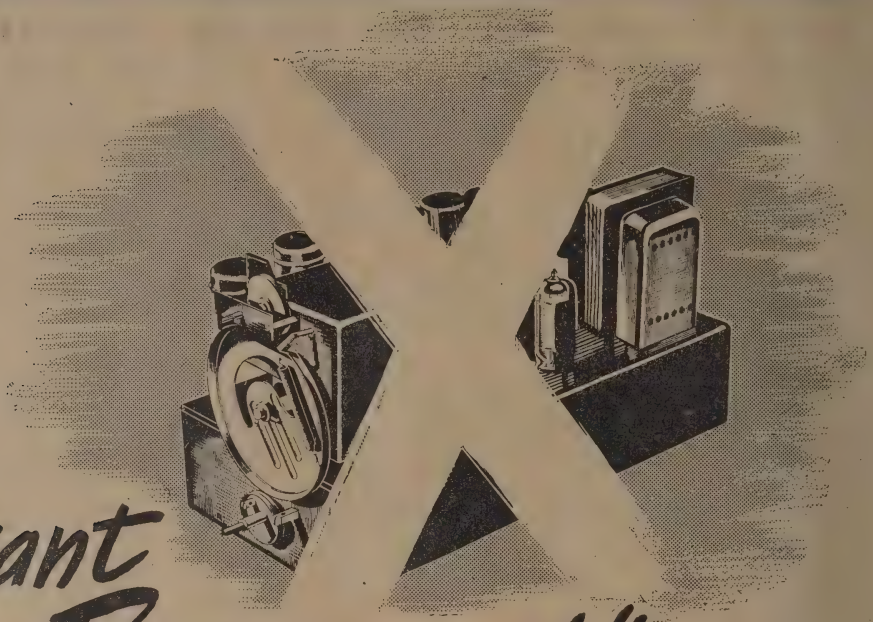

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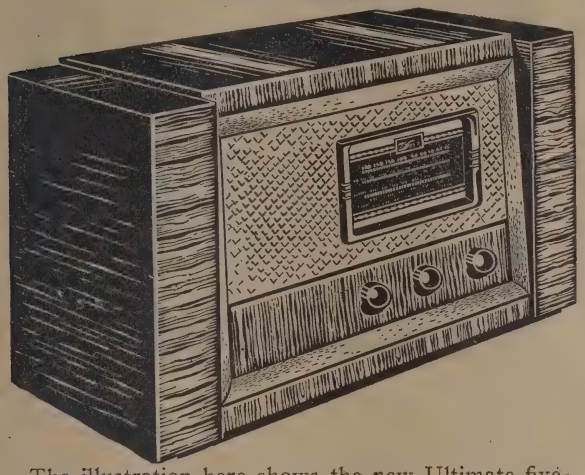
ULTIMATE 5-VALVE BROADCAST MANTEL AND 6-VALVE BROADCAST VIBRATOR RECEIVERS



The illustration here shows the new Ultimate five-valve broadcast mantel receiver and the six-valve broadcast vibrator receiver. These two new Ultimate products have more than the usual number of features. The most popular one is the "Pentonic Tone," already acclaimed by many dealers who have been fortunate enough to obtain the new models out of the first production run.

"Pentonic Tone" enables the radio listeners to choose the tone desired, whether it be extra bass, fine treble, high fidelity, normal, or normal bass.

The simple dignity of the cabinet which houses the two models enables the receiver to harmonize with the room furnishings of any period.

In both the five-valve and six-valve vibrator sets, full provision has been made for a separate gramophone input and for the use of extension speakers.

Ample reserve power in both models enables distant stations to be received strongly.

The new trend in dial design allows full station calibration yet still retains an "open," easily-read panel.

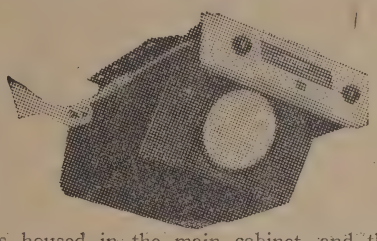
Retail prices: Five-valve Broadcast Mantel, £34 17s. 6d.; Six-valve Broadcast Vibrator, £51.

* * *

H.M.V. Car Radio, Model 516 A/R

Successor to Model 496 A/R, this is similar in shape and external appearance to the earlier model, but has an entirely new chassis layout and complete redesign of its tuned circuits. The design of the aerial coupling transformer, one of the most important points affecting the overall sensitivity and signal-to-noise ratio has been given the closest attention. The good performance of this receiver on weak signals is a measure of the success achieved in this respect.

A two-unit type of construction has been used. The receiver proper with its high-grade permanent magnet



speaker is housed in the main cabinet, and the power supply in a smaller container. In installations where space permits, the power supply is bolted to the back of the receiver cabinet, but when space is at a premium, installation is facilitated by mounting the units separately and using the shielded connecting cable.

Two models are made, one for 12-volt, the other for 6-volt cars. The circuits are similar except for the heater supply, 6 valves, including the rectifier, being used in each model.

* * *

A new R47 Steanes Velocity Microphone is just to hand to Swan Electric Co., Ltd., which will be of great interest to the better-class studios and will fill a want that has existed since the American studio microphone went off the market some years ago.

The new product features bi-directional true figure "8" pattern, allowing artists on both sides of microphone. It is unaffected by temperature, humidity, or changes in air pressure. The response and reproduction over the entire audio range is amazingly smooth and there is a complete absence of cavity resonance and pressure doubling. The movement is shock mounted, full floating, and the microphone combines rugged construction with attractive appearance.

Specifications:

Output level: 77 V.U. into 50 ohms for sound pressure of 1 bar.

Output impedance: 50/200/500 ohms.
Frequency response: 30/15,000 C.P.S. (virtually flat).
Directional characteristics: Bi-directional.
Finish: Florentine bronze.
Mounting: Standard $\frac{5}{8}$ in.—27 threads per inch.
Overall dimensions: Height, 8 in.; width, $4\frac{1}{8}$ in.; depth, $2\frac{7}{8}$ in.
Weight: 4 lb. 5 oz.
Cable: 20 feet twin shielded, tough rubber, sheathed.

* * *

NEW ARIEL PORTABLE

Personal portable radios operating on battery and A.C. power have proved their popularity and are finding an increasingly large market in New Zealand. The latest model "Ariel" battery and A.C. portable combines good performance with smart appearance. Fingertip tuning and volume controls are simple and smooth in operation, while change over from battery to A.C. is achieved instantaneously by means of a slider switch. The chassis has been designed in such a manner as to reduce servicing time to a minimum, a feature which will doubtless find immediate favour with dealers and servicemen. The cabinet is of satin finish perspex, beautifully moulded in grey, cream, or maroon. Specifications are as follows:

Dimensions: 9 inches long, 5 inches deep, 7 inches high.
Weight complete: 7 lb.
Batteries: 467 Minimax "B." C16 9-volt "A"
Valves: DF91, R.F.; DK91, mixer; DF91, I.F.; DAF91, detector; DL92, output; RM1, rectifier.
Retail price: £24 17s. 6d.

The "Ariel" portable is manufactured and distributed by Webbs' Radios Ltd., 11 Wellesley St. E., Auckland.

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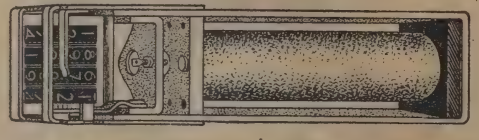

Taken from telephone equipment, these counters are of the 4-wheel type and will operate from the self-contained electro-magnet which could be powered by an ordinary 45-volt radio B battery (operational range, 40/150 volts D.C.). By arranging a contact on a machine, the counter could be put to many industrial uses. The unit may also be used mechanically by disconnecting the E.M. coil. Size 5 in. x $1\frac{1}{4}$ in. x 1 in. Illustration shows unit with metal cover removed—

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VALVE TYPE 4279A (equiv. Type 279A, Western Electric); filament current 21 amps., 3000 volts plate, 600 mills. plate current, 325 grid, GM5, Gain 10, 2,000-ohm plate resistance; 600-watt output

Cat. No. EX1635 ..... **£10**

VALVE TYPE RZ1/150 High-voltage rectifier full-wave—4-volt fil. Current 4 amps. Output 8 amps. each section. Applied anode 1000 volts; rectifier output 1100 volts at 150 m.a.—

Cat. No. EX1637 ..... **10/6**

VALVE TYPE VT90; $7\frac{1}{2}$-volt filament MICRO-PUP

Cat. No. 1636 ..... **12/6**

VALVE TYPE 41MXP (Service No. VR122/CV 1122) "Cossor" 4-volt fil. triode 1 amp. 200-volt Plate 40 ma. screen grid voltage 12.5v.; plate resistance 1500—

Cat. No. EX1640 ..... **1/6**

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NOTE.—None of the material in the 1951 Digest of Circuits *appeared in the original* Digest *which was published two years ago.*

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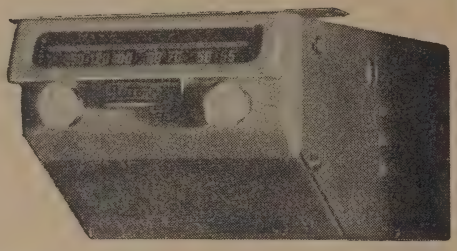

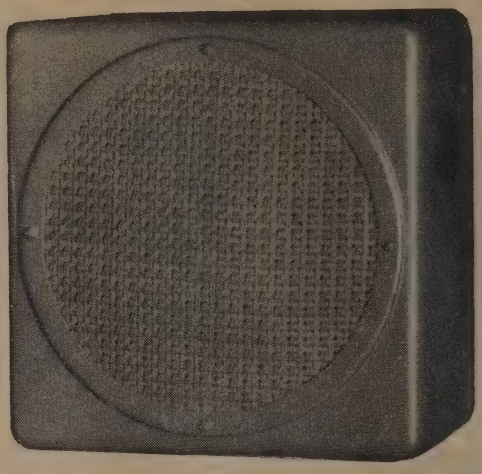

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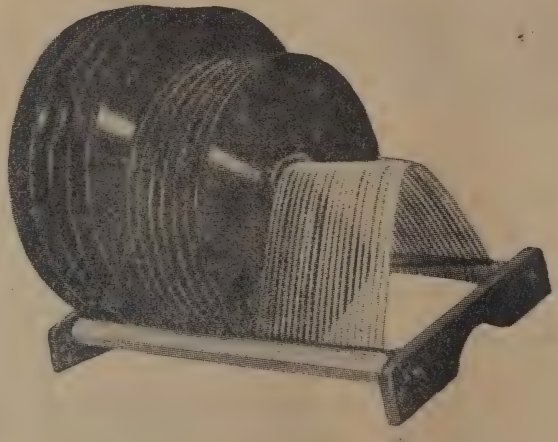

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The "R. & E." 1951 V.H.F. Programme

This short resume indicates the scope of a programme of articles, to be started shortly, on amateur equipment for the V.H.F. bands. There has been of late a quickening interest in this type of work on the part of amateur transmitters, and it is hoped that this series of articles will be of assistance to those who are wondering how to start on this fascinating subject.

INTRODUCTION

In spite of the recently-instituted 160-metre band, and notwithstanding the opening-up of 40 metres to phone enthusiasts, it seems certain that the lapse of time will see more and more active interest in the bands above 30 mc/sec. For practical purposes, this means 50–54 mc/sec., 144–148 mc/sec., and 420–460 mc/sec. There is a regrettable gap in the amateur allocations between the last two of these bands, and the bands above 460 mc/sec. are almost, if not quite, impossible to work with the valves and material at our disposal.

However, we have the means of operating on any of the three bands mentioned above, and of these, the only one presenting some slight difficulty is the last. Even here, however, tubes and techniques that are available are sufficient to work the oracle. The problems confronting the amateur who has not previously tackled V.H.F. operation are not by any means insoluble, and, especially to the technically inclined, are very interesting. To those not so much interested in technique, but rather in communication from place to place, the V.H.F. bands offer a very pleasant change from the overcrowded conditions of the M.F. bands, and there is no reason why these people should not avail themselves of this golden opportunity to get away from Q.R.M.

WHAT ARE THE REQUIREMENTS?

We all know, in some sort of way, that receivers and transmitters for the V.H.F. bands are different from their M.F. counterparts, and, in our opinion, it is the realization of this difference, without a great deal of knowledge what the differences are, that manages to scare off quite a number of would-be V.H.F. fans. They think that because Tom, down the road, has had lots of no success in getting started on 6 metres, or, more likely, on 2, they would find themselves in the same unenviable boat were they to try their hand themselves, and as a result, decide to give it a miss. It is to help people like this, as well as those who are already confirmed V.H.F. addicts, that the present series of articles has been prepared. Up till now, we have presented a number of practical articles describing equipment for all the bands mentioned earlier, but they have not been co-ordinated, and it is felt that a definite programme would be of more assistance and interest than more articles chosen more or less at random.

GENERAL SCHEME OF THINGS

To all appearances, then, we have bitten off a fairly large mouthful. The subject automatically divides itself into two compartments, transmitters and receivers, but in reality there are six parts, because we have both sections applied to each of the three bands. But things are seldom as bad as they seem, and it will not be too difficult to arrange things so that some of the gear for the lower bands is usable for working all three. In this way, not only is expense saved, but also the V.H.F. learner, as we may perhaps call him, can progress from building and operating technique that is not so very different from standard H.F. practice to things that are decidedly new to him. Let us see, then, what we are up against if we decide to embark on the great migration.

RECEIVERS

At the outset, it is best to forget all about ordinary H.F. practice, and start from scratch, without any preconceived ideas. The best way to do this is to set up a list of requirements for a V.H.F. receiver, see in principle how they may be fulfilled, and **then** look at what we have to see how different it is from our existing receivers. We will not then be tempted to incorporate features from our H.F. jobs that serve no useful purpose, or are actually disadvantageous in a V.H.F. receiver.

(a) **Type of set.**
Here, it has to be decided whether we are to go for a superhet. (straight, or double conversion), a T.R.F. (with or without regeneration), or a super-regenerative detector.
(b) **Selectivity required.**
(c) **Sensitivity needed.**
(d) **Signal-to-noise ratio.**
(e) **Image rejection (if a superhet.).**
(f) **Bandwidth.** (This topic is not really covered under (b).)
(a) **Additional features** (Xtal filters, B.F.O., A.V.C., etc.).
(h) **Complexity and cost.**

The first of these cannot properly be answered until (b), (c), and (d) have been examined, but our general knowledge of the characteristics of the types of set mentioned should enable at least a partial decision to be made. The superhet. can be designed to have any desired degree of sensitivity, selectivity, image rejection, and signal-to-noise ratio, and at first sight would seem to be the answer, but the claims of its rivals should be examined before they are discarded, if they are.

The T.R.F., with or without regeneration, becomes increasingly difficult to handle as frequency gets higher, and may also be criticized on the score of stability, unless it is designed for great bandwidths, as in television receivers. Signal-to-noise ratio is good, however, but the difficulty of getting high enough sensitivity and selectivity to be useful, combined with the instability problem, puts it out of court.

On the other hand, the super-regenerative set has undeniable points in its favour. It is the ultimate in sensitivity for the smallest number of valves, which alone gives it a considerable advantage over other arrangements. Also, like the T.R.F., it has no image response. On the other hand, it tends to be critical in adjustment, and its characteristics, even today, are not as easy to reproduce as to make it a suitable receiver for serious work. Of course, there are applications in which the super-regenerative is supreme, assuming that the frequency is high enough, but for the application we have in mind, its advantages are

outweighed by its disadvantages. For fixed-station use, its sensitivity, high though it is, is not adequate; except for the reception of modulated-oscillator transmitters, its selectivity is not good enough, and its signal-to-noise ratio is very poor for signals lower in level than is required to stop the super-regenerative hiss. Unless preceded by an R.F. stage, or a superheterodyne mixer, it radiates a broad signal that is a source of interference in other receivers. It has the curious feature, according to one authority, that the addition of an R.F. stage does not sensibly decrease the strength of signal that is required to overcome the hiss. so that perhaps the greatest advantage of the R.F. stage is lost if it precedes a super-regenerative set.

From the above, it is clear enough that the logical choice for (a) is the superheterodyne. But there is a wide variety of superhets., and we are still left with many decisions to make.

REMAINING FEATURES

For a fixed station, then, we have clearly settled on a superhet of some kind for the receiver. It is not proposed to go further into the question of what sort of superhet at this stage, for that will be more appropriately dealt with when we come to describe the actual receiver or receivers. The exact details of the design will depend on the answers to the implied questions contained in the list above, but it would perhaps not be inappropriate here to indicate what we have in mind for covering the three bands, at least on the reception side.

If the requirements of each band were taken on its merits, it might turn out that the best possible answer would be an entirely separate receiver for each band, but this would obviously be a solution to be avoided if at all possible, because of the expense. At lower frequencies we would hardly think of building completely separate receivers for each band, and here, band-switching turns out to be the almost universal solution to the difficulty, but on the face of things, it does not seem very likely that band-switching would be practicable for three such widely spaced bands as 50, 144, and 420 mc/sec. If separate receivers are "out" on grounds of expense, and band-switching is, too, because of impracticability, what are the remaining alternatives?

First of all there is our old friend, plug-in coils. It might be possible to arrange this, with conventional LC circuits used for six metres, and different types of tuned line for two metres and 420 mc/sec., but the difficulty of making suitable tuned circuits for the latter frequency —circuits that could be variably tuned by the same condensers that will be used for six metres—rather puts one off the idea.

Perhaps the most attractive idea that presents itself is the following. Suppose we construct a superhet specially for six metres—with one or two reservations. It will have less selectivity, for instance, than *could* be used on this band, because crystal control at the transmitter is a simple matter these days; on the two remaining bands, however, signals are much less likely to be crystal-controlled. Indeed, on 420 it can reasonably be expected to be very rare for some time to come.

This six-metre receiver can have an efficient R.F. stage, and such advanced features as a triode mixer and ganged tuning, and, indeed, can be a very good set indeed without introducing too much in the way of expense or constructional difficulty. If the I.F. is higher than 2 mc/sec., it will be impossible for images to fall inside the band, and if it is made considerably higher than this,

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THIS FEDERATION is a live body protecting the interests of Radio Traders throughout New Zealand. There is an affiliated Association in your district. Inquire for full particulars and join up now.

USE THIS FORM

To the Secretary,
New Zealand Radio Traders' Federation,
P.O. Box 796,
WELLINGTON.

Please advise me what Radio Traders' Association covers my district and send me full particulars regarding membership.

Name of Firm .....

Full Address.....

New Zealand Headquarters :: :: :: :: 8-12 The Terrace, Wellington

the image response will be very small in any case. Since the set is built as a single-band one, the best possible L/C ratio can be used in the tuned circuits, and the mechanical layout will not have to be sacrificed on account of other, really extraneous considerations, as is often found in multi-band receivers. This set then forms the basic unit for all our V.H.F. reception.

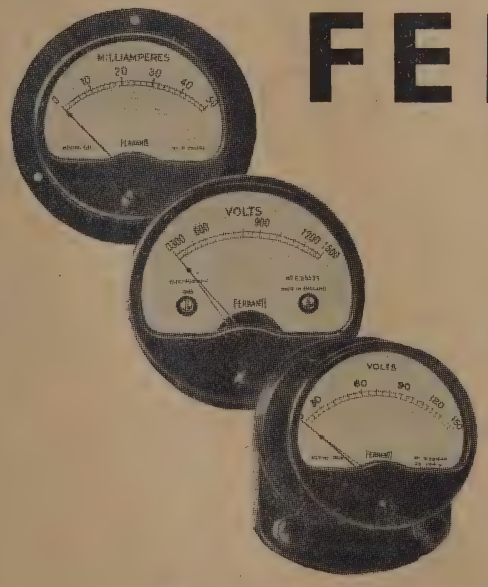
For two metres, and 420 mc/sec., then, the idea is to build special converters. This enables each band to be received almost, if not quite as well as if entirely separate sets had been designed, for the "front end" in each case is made solely for its own band, and likewise contains no compromises which will reduce its performance. There are still two possibilities which must be explored before the final system is decided upon. The first is to make the converters fixed-tuned, converting their respective bands to six metres, where the six-metre set is used as a tunable first I.F. in what amounts to a double superhet. The second is to provide the converters with their own tuning arrangements, and to set the dial of the six-metre set to a pre-determined point which is to act as a fixed first I.F. in the double-conversion arrangement.

For the two-metre band, either of these arrangements would be quite practicable, because this band is four megacycles wide, and so is the six-metre band, so that a fixed-tuned converter would be able to change 144–148 mc/sec. to 50–54 mc/sec. But on 420 mc/sec., the band extends from 420 to 460 mc/sec., so that a fixed-tuned converter would only be able to take four megacycles of it at a time, and the converter would have to be able to be switched to ten frequencies to enable the tunable I.F. to explore the whole band! Here, then, the tuning arrangements will have to be made on the 420 mc/sec. converter itself. Even so, whichever scheme is chosen for the two higher bands, the three units, comprising six-metre receiver and two converters, will enable good reception to be had on all three bands for the minimum expenditure of time and money.

TRANSMITTING ARRANGEMENTS

Unfortunately, it is not quite so easy to settle on a cut-and-dried scheme for transmitting circuits for the three V.H.F. bands. This is partly because such a wide variety of arrangements *can* be used that it is almost impossible to know where the start! As was mentioned above, there is no reason why crystal control should not be used on six metres as long as crystals on suitable frequencies are available. At one time, when the amateur V.H.F. bands were in harmonic relationship to the H.F. bands, crystal control did not present such a problem, since some crystals could be chosen to be useful on almost all bands from 80 to 5 metres. However, unless war surplus crystals, at low prices, can be obtained on suitable frequencies, many amateurs will not feel much like spending money on crystals that can only be used on one V.H.F. band each! Another difficulty about crystal control is that for the very high bands, in particular 420, it is difficult to retain a clean note, simply because of the high degree of frequency multiplication needed before the final frequency is reached.

It is proposed, however, to describe a number of alternative arrangements. In general, a chain of multipliers can be used both on six and two metres without any coil changes, because, although these bands are not in exact



FERRANTI

2½ in. INSTRUMENTS

ACCURACY on a BIG SCALE

110° 2½ in.

FERRANTI accuracy possible only with a FERRANTI instrument.

MOVING COIL, MOVING IRON, RECTIFIER, ELECTROSTATIC, THERMAL instruments available in flush, portable, and projecting patterns.

All these instruments are of accuracy guaranteed within the limits of the British standard specification for first-grade instruments.

New Zealand Distributors:

ARTHUR D. RILEY & CO., LTD.

124 Hobson Street, AUCKLAND

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harmonic relationship, they are nearly so, and by carefully choosing the band coverage of each stage, it can be used for either band simply by providing the right input frequency and re-tuning. One useful thing is that the 420 mc/sec. band is almost at the third harmonic of the two-metre band. Tripling from the 144 to 148 band gives output at 432 to 444 mc/sec., so that any frequency within the two-metre band can be tripled in the certain knowledge that the output frequency is within the 420 band. The two-metre transmitter can always be given a frequency range of 140 to 153.3 mc/sec., so that tripling can cover not just a part, but the whole of the higher band. As can be seen, there are numerous possibilities, and in our opinion, the best arrangement for the man who wishes to work all three bands, is to design a V.F.O., on a fairly high frequency, that can be multiplied into each band. This should not be too difficult, and, although the stability may not be quite up to the best that crystal control can do, it should be more than adequate for satisfactory working, and far, far better than the old self-excited oscillator, directly modulated. As readers will be aware, there is almost unlimited scope for ingenuity in design and construction, allied to not very high first cost, since low powers are quite satisfactory for almost all V.H.F. purposes. About the most difficult thing is to find suitable transmitting tubes for the 420 mc/sec. band. If ten watts or more is wanted on this band, it will probably be essential to spend a little money on a tube or tubes that will handle this band well, but as against that, there will be almost nothing to spend on parts of the gear that eat up quite a lot of cash at lower frequncies—high-voltage tank condensers, etc. Altogether, we expect to have quite a lot of fun with the *R. & E.* V.H.F. programme, and it is our earnest hope that those of our readers who follow the series of articles will do so too.

AUTOMATIC FREQUENCY SELECTOR USED AT SEA

Quick and accurate methods of tuning transmitters to the distress frequency are of vital importance in maritime radio-telephone installations. In the past many distress signals from fishing vessels and other small craft have been sent out on the wrong frequencies owing to the difficulty of finding the distress frequency in the dark.

This problem has been overcome in the "Mermaid" Radio-telephone Equipment, manufactured by a British electrical firm, which incorporates an automatic selector to select any one of eight pre-set wavelengths between 1.6 and 3.8 megacycles.

The mechanism can be worked in the dark by touch and only takes two seconds to operate. As a result tuning adjustments are much more rapid and certain than with manual tuning.

Besides finding important use for automatic frequency selection in radio transmitters, auto-selectors have a great value in industrial and marine functions where extremely accurate operations have to be repeated many times.

RADIO COURSES

If you are interested in Radio as a Career, don't call S.O.S. Call the

NEW ZEALAND RADIO COLLEGE

24-26 Hellaby's Buildings - - Auckland, C.1.

FOR YOUR TRAVEL INFORMATION

Railways and Road Services Timetables

A new edition of the North Island Railways and Road Services Timetable is now on sale at all railway and principal road service booking offices. Priced at one shilling, this attractive 88-page booklet is an invaluable travel guide for home or office use. It is designed also to fold conveniently for pocket or handbag. A supplement with each booklet summarizes the emergency train schedules which operate during the prevailing coal shortage.

South Island Timetables (issued May, 1950) are also available.

GET YOUR COPY TODAY

"R. & E." TECHNICAL PHOTOGRAPHS

Good clear black-and-white photographs of original designs produced in our laboratory, as featured in these pages, are available at a small charge. Build your gear to look like the original models and use photographs for complete check. The small cost will more than repay with satisfying results and make all the difference to the finished job.

PRICES

Size 6 in. x 4 in.	**3s. 6d.**
Size 8 in. x 6 in.	**4s. 0d.**
Size 10 in. x 8 in.	**5s. 6d.**

When ordering, please remit cash, quote date of issue and page number, and PRINT your name and address.

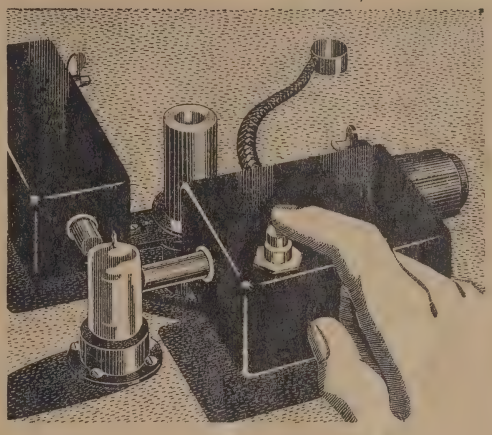
Address to:

RADIO & ELECTRONICS (N.Z.), LTD., P.O. Box 8022, WELLINGTON

WHAT "Reception-Tested" REALLY MEANS

Before they are carton-sealed, every Brimar Valve has passed with full marks 10 rigid and exacting factory tests—static, vibratory, dynamic, followed by heat treatment, and finally "noise and gain" examination in a test circuit.

Test illustrated here shows valves undergoing vibration tests. Hammers strike the valves alternately from directions at right-angles, whilst meters record the effect on valve characteristics. This ensures that each Brimar Valve will give long and continuous satisfaction under the most arduous conditions . . . perfect radio performance.



Some of the valve types available here in New Zealand are:

	R.F. Tubes	Mixer Tubes	I.F. Tubes	2nd Detector	Output Tubes	Rectifier Tubes
1.4v. Battery Types	1T4	1R5	1T4	1U5	3V4	—
6.3v. Loctal Types	7H7	7S7	7H7	7K7	7C5	7Z4
6.3v. Octal Types	6K7GT	6K8GT	6K7GT	6B8GT	6V6GT	5Y3GT
6.3v. All-Glass Types	6BA6	6BE6	6BA6	6AT6	6AQ5	6X4

PROTECT YOUR CUSTOMERS . . .
PROTECT YOUR GOODWILL . . .
STOCK AND RECOMMEND

BRIMAR

BRITISH RADIO VALVES

"RECEPTION-TESTED" for your protection!

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AN STC PRODUCT

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Ask your Brimar Representative for new display material.

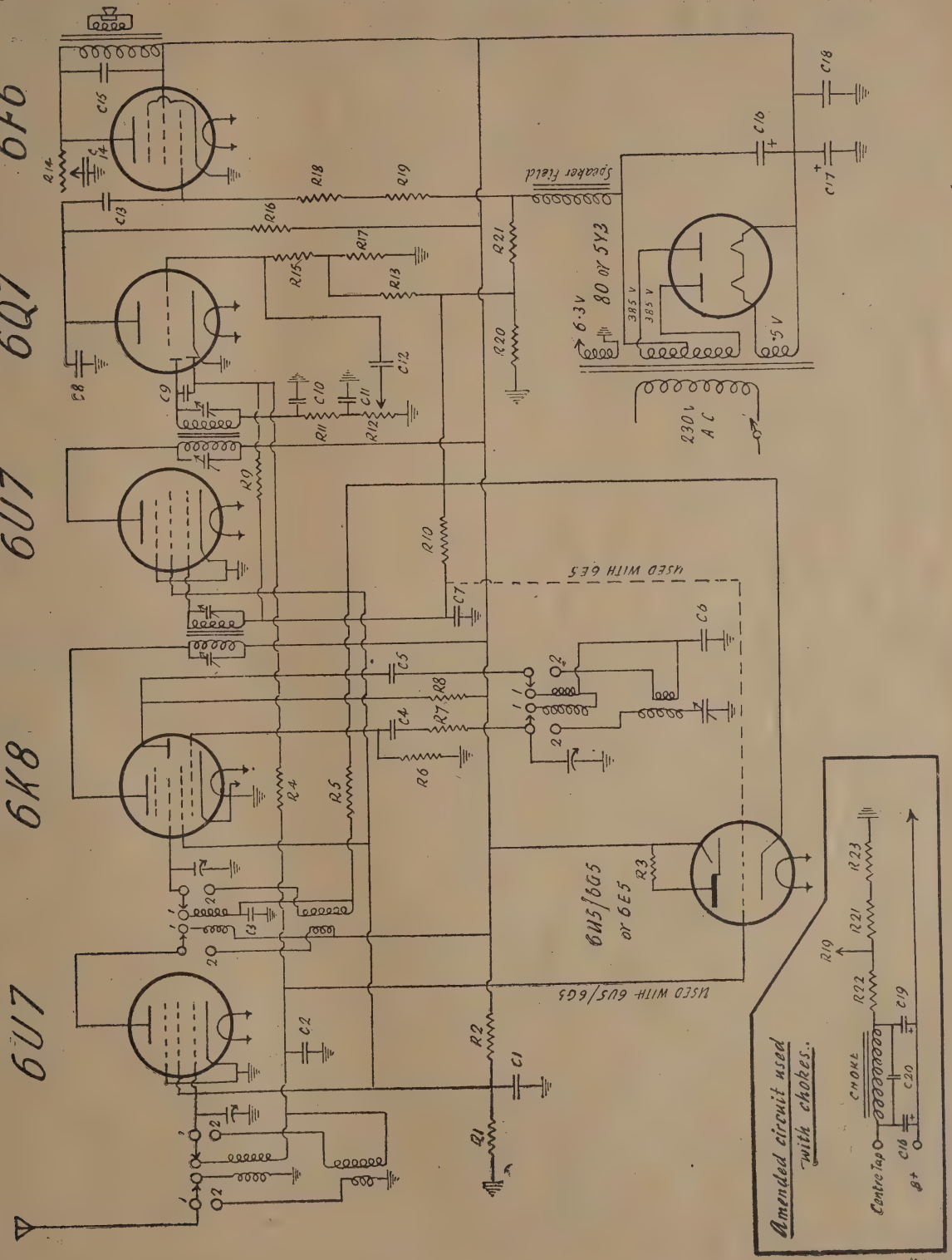
FOR THE SERVICEMAN: NEECO MODEL 46-D

COIL COLOUR CODE

Coil	Aerial	R.F.	Oscillator
Colour	(Green)	(Black)	(Blue)
RED	BC Aerial	B +	Sw Padder
BLACK	AVC	AVC	Bc Padder
GREEN	Bc Grid	Bc Grid	Bc Grid
BLUE	Sw Grid	Sw Grid	Sw Grid
BROWN	Earth	Earth	Earth
YELLOW	Sw Aerial	Bc Plate	Bc Osc. Plate
PLAIN	—	Sw Plate	Sw Padder
PINK	—	—	Sw. Osc. Plate.

COMPONENTS LIST

C1, 18	equals	.1	mfd.	R1	equals	.025	Megohm
C2, 3, 7, 14	,,	.05	mfd.	R2	,,	.015	Megohm
C4, 10, 11	,,	.00005	mfd.	R3, 4, 9, 15	,,	1	Megohm
C5, 8	,,	.00025	mfd.	R5	,,	.1	Megohm
C6	,,	.003	mfd.	R6, 8, 11, 19	,,	.05	Megohm
C9	,,	.00015	mfd.	R7	,,	100	Ohm
C12, 13	,,	.01	mfd.	R10, 13	,,	.5	Megohm
C15	,,	.005	mfd.	R16, 17, 18	,,	.27	Megohm
C16	,,	16	mfd.	R20	,,	50	Ohm
C17, 19	,,	8	mfd.	R21, 22	,,	250	Ohm
C20	,,	.25	mfd.	R23	,,	25	Ohm
	R12		equals 500,000	Ohm Potentiometer			
	R14		,, 50,000	Ohm Potentiometer			


6F6
6Q7
6U7
6K8
6U7
Speaker field
6·3v
80 or 5Y3
385 V
385 V
5 V
230 v
A C
C18
C16
C17
R14
C14
C15
C13
R16
R18
R19
R15
R17
R13
R21
R20
C8
C9
C10
C11
C12
R11
R12
R9
R10
C7
C6
C5
R8
R7
C4
R6
R4
R5
C3
C2
R2
C1
R1
6U5/6G5
or 6E5
R3
used with 6E5
used with 6U5/6G5
Amended circuit used with chokes.
R19
R21
R23
R22
C19
CHOKE
C20
C16
Centre tap
B+

THE B.T.H. GERMANIUM CRYSTAL DIODE

Recent advances in manufacturing techniques have made it possible to mass produce the germanium crystal diode and thus successfully to compete, in performance and price, with other types of rectifier, hitherto exclusively used in certain radio and electronic apparatus.

One important application, for example, is to television receivers, where any number up to nine diodes—usually thermionic—may be required for different functions.

Apart from competitive price, the crystal diode has many advantages over the thermionic type, and its life under normal conditions is indefinite. It is wired into the circuit—without the complication of a valve holder—just like a resistor or capacitor—and its characteristics can now be determined without selection.

The CG5 type is used wherever the frequency sensitivity is important: as the first or second detector for frequencies up to 200 mc/sec.

The CG6 type is generally less sensitive as an R.F. detector, but it will handle higher input voltages, required in television sets for selecting, limiting, and separating the picture synchronizing impulses, and for regulating the brightness of the picture.

It can also be used to limit the magnitude of impulsive interference—so often experienced from the ignition systems of motor-cars and the like.

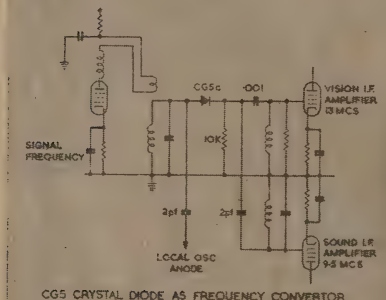
Other applications include automatic gain control, and as the twin diodes in the discrimination circuit of frequency modulated receivers. All these applications are shown in the illustration and include circuit data.

It is also of interest to record that in the recent epoch-making relay of television pictures across the English Channel, B.T.H. crystals Types CS 3A and CG1-C were used in the special microwave relay equipment.

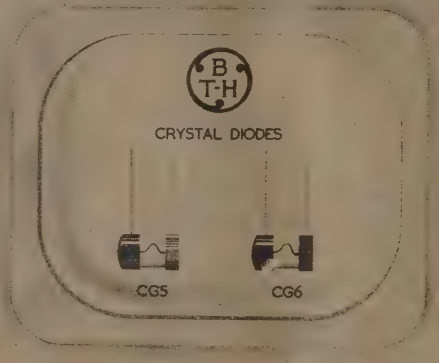
Sole New Zealand Representatives:

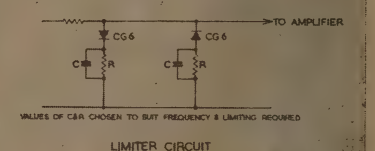
THE NATIONAL ELECTRICAL & ENGINEERING CO., LTD.

SOME APPLICATIONS OF THE GERMANIUM CRYSTAL DIODE TO TELEVISION & RADIO CIRCUITS

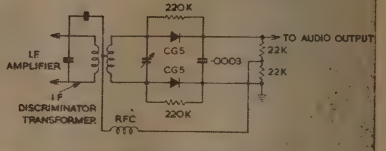


CG5 CRYSTAL DIODE AS FREQUENCY CONVERTOR

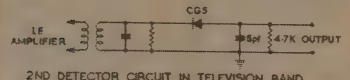




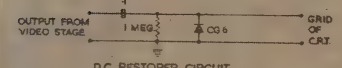
LIMITER CIRCUIT



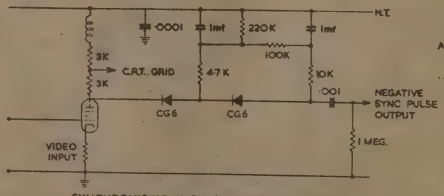
U.H.F. DISCRIMINATOR CIRCUIT



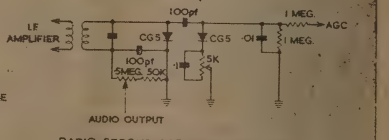
2ND DETECTOR CIRCUIT IN TELEVISION BAND



D.C. RESTORER CIRCUIT



SYNCHRONISING IMPULSE SEPARATOR CIRCUIT



RADIO SECOND DETECTOR AND A.G.C.

THE N.Z.E.I.

NEWS LETTER

ANNUAL REPORT OF THE COUNCIL

Gentlemen,

Your Council has pleasure in submitting its Annual Report for the year ended 31st May, 1951.

Meetings

(a) Annual Meeting.—The Annual General Meeting provided for under Section 17 of the Constitution, was held in Room 9A, Ground Floor, Air Department Building, Bunny Street, Wellington, on Wednesday, 14th June, 1950.

(b) Council Meetings—Seven Council Meetings were held during the year in addition to which sub-committees appointed by the Council met to implement various projects.

Postal Ballots

Under authority of Section 16 (e) your Council conducted two postal ballots to determine:

(a) Amendments to the Membership Rules (Sec. 5 and 6). (Amendments carried.)

(b) The addition of a new rule granting proxy representation at Council meeting. (Carried.)

(c) Whether or not the Institute should establish a monthly Journal by the adoption of *Radio and Electronics* as its official organ. (Journal established.)

Membership

The current financial membership figures now total 133 as against 123 last year. Details are appended below:

	O/seas.	Auck.	Ch'ch.	D'din.	Wgtn.	Total.
Members	0	1	2	0	5	8
Associate Mbrs.	2	4	10	10	22	48
Associates	2	12	17	12	17	60
Students	0	4	5	4	4	17
	4	21	34	26	48	133

During the year the Admissions Committee functioned most successfully and all applications received were carefully scrutinized.

Branches

1. Auckland—Although several efforts have been made to interest members and prospective members in Institute affairs in Auckland, difficulty has been experienced in maintaining activities.

Your Council would express the wish that the 21 members in Auckland will in the future give every support and encouragement to their executive officers and thus assist in the fulfilment of the Institute objectives.

2. Christchurch—A full and successful year of activities can be recorded from Christchurch where regular meetings and field days attracted the attendance of several members.

In addition, personal representation at Council was secured by the attendance of Mr. B. T. Withers who was present at Council meeting held in December, 1950.

It would appear that Christchurch Branch is firmly established.

3. Dunedin—Regular meetings, talks, and operational displays of equipment held in the residence of Mr. W. L. Shiel maintained the enthusiasm of members in Dunedin. Mr. Harris was also in attendance as an official representative of Otago at the Council meeting held in February, 1951.

4. Wellington—Under the capable leadership of Mr. W. D. Foster, Wellington Branch has made considerable prgoress. Evening meetings commencing at 5.30 p.m. have proved to be most popular with members and in addition, the growth of the library will gradually fulfil a long-felt want and keen demand for electronic literature.

The highlight of the year's activities was the special provision made for Institute members to see the first official display of television in Wellington, held in the National Broadcasting Service studio during March, 1951.

Finance

The financial statement reveals a credit balance of £198 9s. 7d. as against £131 6s. last year. The prudent management of finances has greatly assisted strengthening the position of the Institute and enables your Council to initiate a progressive policy.

Membership Certificates

All financial members other than students, have now been issued with certificates and the recipients would be assisting the Institute if certificates are framed and displayed.

Educational

During the period under review all students were circularized and given full information respecting the Institute examinations which were duly held in November, 1950. Your Council would extend congratulations to the three successful candidates, viz.:

(1) Adrian E. Adam, c/o Y.M.C.A., Christchurch.

(2) Athol Bruce Forsyth, High School, Opotiki.

(3) Ronald F. Harrison, Civil Aviation Branch, Wellington.

Future examinations will be held immediately a revised syllabus becomes available.

Prize Awards

The following prize awards were authorized during the year under review, for the most successful candidate who gained the highest mark in the Radio Serviceman's Examination.

March, 1950—Brian Martin Duff, Signal Repair Station, R.N.Z.A.F., Ohakea.

September, 1950—Eric Russel Petherick, 12 Reuben Ave., Brooklyn, Wellington.

March, 1951—John Henry Weir, Radio Corporation of New Zealand, Wellington.

Official Organ

The publishing of the Institute's own journal to include its Proceedings was given serious consideration but it was decided that initially it would be wiser to combine with an established journal. We were fortunate in being able to make very suitable arrangements with *Radio and Electronics* in this matter.

In accordance with the result of the postal ballot therefore, all members now receive regularly each month a copy of *Radio and Electronics* in which is published the Institute newsletter. Contributions from members for publication in this newsletter would be welcomed.

Institute Insignia

An official emblem for the Institute has now been formally adopted and will appear on all future publications and stationery emanating from the Institute.

Brochure

An attractive brochure outlining membership details is at present being distributed and should result in a quickening of interest in the Institute generally. The brochure explains in simple language the procedure for and advantages of becoming a member of the Institute, in addition to outlining the major objectives of the Institute itself.

Thanks

Your Council, on behalf of the Institute, extends its thanks to—

(1) Those trading organizations who so generously continued their donations to the Institute.

(2) The proprietors of *Radio and Electronics* who grant the Institute free space each month for its newsletter.

(3) Branch executive officers and members who actively supported Institute functions during the year.

(4) Those individuals who gave addresses and displays of operational equipment for the benefit of Institute members.

(5) Philips Electrical Industries of New Zealand Ltd. for donations of technical literature.

(6) The staff of the National Broadcasting Service who made it possible for Institute members to view the first official display of television in New Zealand.

(7) All others who directly or indirectly contributed to the successful year experienced by the Institute.

Looking to the future it can be stated with confidence that the demand for electronic knowledge is increasing and with this demand, the Institute can and will fulfil its

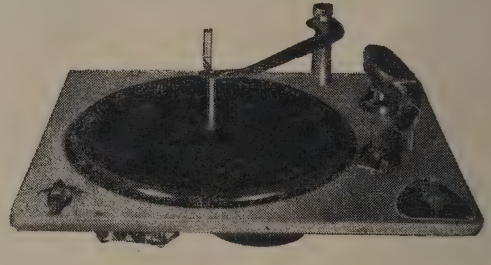
(Concluded on page 48.)

Collaro ***Quality Products***

The Collaro RC500 Record Changer

A brilliant automatic record changer, specifically designed for simplicity and reliability. Plays nine 10 in. or nine 12 in. records. Incorporates spring suspension, which eliminates acoustic feed back. And it's foolproof against jamming.

Available with a choice of pick-up including magnetic, crystal, and high-fidelity models. Both models suitable for A.C. supplies only.



The Collaro 3RC511 Record Changer

A completely automatic three-speed changer designed to "take all records"! 3RC511 plays 33⅓, 45, and 78 r.p.m. records with a minimum need for adjustments. Fitted with pick-up arm, suitable for all types of Collaro plug-in heads. Beautifully made and completely foolproof.

Sole New Zealand Distributors:

RUSSELL IMPORT CO., LTD. WELLINGTON

Trade Winds

WELLINGTON RADIO TRADERS' ASSOCIATION

The Annual General Meeting of this Association was fixed for 26th July, which date coincided with this journal going to press. A full report of this meeting will, therefore, not appear in these pages until the September issue..

The President's report for the year ending 31st May, 1951, is as follows:—

Gentlemen,

Radio traders have enjoyed, together with practically all other sections of the business community, buoyant trading conditions during the year under review. Sales of new sets have been most heartening, and towards the end of the year the threat of rising prices gave an extra impetus to public buying.

Procurement of stock, particularly replacement parts, is becoming more difficult. Your Association is aware of the situation and has already made representations in an endeavour to secure a continuity of spares of all types which are so necessary if we are to give the public proper service.

We should not let the present prosperity of our industry lull us into a position of false security, but should individually endeavour to increase our efficiency as traders.

Another pleasant feature of trading is the co-operation that exists through all channels of radio distribution—between the manufacturer, wholesaler, and retailer. Eac his dependent upon the other and co-operation is forthcoming in all directions. Nevertheless this could be further developed if retail members would come along to meetings in strength. Discussion can often forestall problems. There is also room for some prominent traders who are not members, whose views we do not hear, whose opinions and co-operation would still further strengthen our Association. Can you influence at least one such trader to join us?

As an Association we are continually watching the interests of traders, and you will be glad to know that representations we have made along with other trade organizations have resulted in positive steps being taken to cope with the increasing tendency of interference. This should react to the benefit of the trade, for all will appreciate that unless the standard of reception is high, we cannot expect to maintain the volume of sales, especially of the higher priced equipment.

We are already into a new trading year, and if the present trend of business is maintained all sections of the radio trade can look forward to another prosperous year. In conclusion I would like to express my thanks to all members who have actively supported the Association during the past year. The secretarial affairs have been handled in the latter part of this year by Mr. P. J. Luxford, and I feel that this has strengthened the Association, and to him and all associated with him at the New Zealand Employers' Federation I would like to express my appreciation for the services given.

W. YOUNG, *President.*

* * *

Mr. T. J. F. Spencer, Managing Director of Akrad Radio Corporation, has left for a business trip to the United Kingdom.

Mr. G. J. Benn, industrial chemist of Ducon Condenser Ltd., Aust., was in New Zealand in July for conference on induction techniques and general get-together with the engineering staff of Ducon N.Z. Ltd.

* * *

Mr. Nelson-Jones, co-founder and lately managing director (now retired) to the National Electrical and Engineering Co., Ltd., left by the *Dominion Monarch* in July for South Africa where he proposes to stay tor an indefinite period at Bulawayo with his son John, who has a senior executive position with the Municipal Electricity Department there.

* * *

Mr. A. J. Skilton, of Skilton Radio Services, was in Wellington on a purchasing tour in July.

* * *

Mr. H. J. Stone, Executive Director, and Mr. C. Murray, Export Sales Manager, of B.I.C.C., London, with Mr. F. G. Edwards, B.I.C.C. General Manager for Australia, have recently made a brief visit to New Zealand.

* * *

Sir Charles Norwood, Chairman of Directors of National Electric and Engineering Co., Ltd., left on the *Dominion Monarch* for a holiday in his native Australia.

* * *

Two old hands of our N.E.E.Co. Ltd. Kaiwharawhara factory have recently left to take up other positions. John Rodger, Superintendent of the vitreous enamelling department, who joined the company in March, 1936, has taken up a position with G. H. Mooney and Co. A. (Andy) Stephen, who had been with the company practically from the inception of range manufacture, and who had been superintendent of range assembly, has entered business on his own account as an electrical wiring contractor. Both were the recipients of presents from their fellow employees on the eve of their departure.

* * *

Swan Electric Co., Ltd., have secured larger warehouse premises in Wellington about which we shall hear more soon.

* * *

Two members of the staff of Cory-Wright and Salmon Ltd., have recently completed twenty-five years service wtih the firm. They are Mr. W. Dykes, the accountant at Head Office, and Mr. A. Davies, Waterworks Department. Both received worthy congratulations from the management and staff colleagues.

* * *

B. S. Brailsford, Christchurch Manager for Bradley's Electrical Company, Ltd., was in Wellington recently for a Managers' Conference.

* * *

Mr. A. J. Wyness returned in August from his business trip to the United Kingdom.

* * *

There are are big staff changes in Swan Electrical Co. Ltd., Wellington.

Brig Mason is shortly transferring to the Auckland Branch in an advisory capacity to Mr. W. J. Blackwell, Managing Director. Brig has not enjoyed the best of health for some months past and we sincerely wish him success in his new appointment and that the change to the warmth of Auckland climate will help to speed up recovery to full health.

Taking over Mr. Mason's position as Wellington Manager is Mr. W. H. (Bill) Lee, whilst J. S. (Staff) Oxley has left the factory side of the business taking

on the position of Sales Manager, and Mr. R. P. (Bob) Hodge, previously the company's Wellington factory engineer, has been appointed Wellington Factory Manager. Our best wishes go to the above for success in their new appointments.

* * *

Rebuilding activities seem to be the order of the day with radio firms in Auckland. Chas. Roser, who spent a few days there during July, saw the new premises of Autocrat Radio Ltd., who have a commanding site on the Great South Road. Projected redesign of the front of the building will make an attractive feature.

A hive of workmen was busy at Radio (1936) making extensive alterations to the offices in the administrative section of the main building. The block next door, recently purchased by this firm has already become a shell for modernization for factory production purposes.

Electronic Navigation Ltd. have for some time been making extensive alterations and will shortly be moving to the top floor of Nagel House where a perfect example of the utmost use of restricted space may be seen. Neat semi-separated test benches catch the eye, built around the office section in a way that avoids noise and interference.

Johns (1950) Ltd., new premises show signs of an early completion of what is claimed to be a "science of selling" layout. A visit to this attractive showroom will be well worth the short climb from Queen Street. More will be told of this enterprising development in a subsequent issue.

Antone Radio Ltd. have made extensive alterations since *R. & E.* called on them last. The layout of their Queen Street premises speaks well for this recently established firm.

Miles Nelson Ltd., who last year planned a large and modern warehouse and offices in Surrey Crescent, have been delayed by shortage of labour and materials. Progressing necessarily slowly, however, they have plenty of space and things are shaping well.

Stebbings Sound Systems are putting the finishing touches to warehouse space in Surrey Crescent and their Sound Studio at Wellesley Street has an artistic pleasant setting.

Many other contacts were made and Chas. H. Roser regrets being unable to see all friends of *R. & E.* but hopes to make up for this in another visit to Auckland shortly.

* * *

The Morrinsville Veterinary Club is to install radio telephones in two Morrinsville and two Matamata veterinarians' cars. A station will be established on a farm on Hangamera Road where a 60 feet aerial should provide coverage to the boundaries of the club's territory, enabling direct contact to be made with the Morrinsville office. Two 15-watt stations remotely controlled over P. and T. lines are to be employed. The equipment is from "Pye" by Green and Cooper, Ltd. An expenditure of £2,000 is involved.

* * *

Ken McEwen (ZL2WS) now O/c transformer department of Telecommunications Ltd., is flat out putting the hi in high fidelity.

PUBLICATIONS RECEIVED

Electronic Application Bulletin, September, 1950. N. V. Philips, Eindhoven. (Philips Electrical Industries of N.Z., Ltd.)

Electronic Measuring, No. 4, Vol. 3. Philips Electrical Industries of N.Z., Ltd.

R.C.A. Transmitting Tube Manual, TT3. National Electrical and Engineering Co., Ltd.

Westinghouse Engineer, May, 1951. H. W. Clarke (N.Z.) Ltd.

Enterprise, June, 1951. Cory-Wright and Salmon, Ltd.

Sales Literature, Steanes Sound Systems. Swan Electric Co., Ltd.

Descriptive Bulletins, "Airmec" Instruments. Green and Cooper, Ltd.

Price List and Data Sheets, Hy-Line Coils and Inductances. Wiseman Electric Co., Ltd.

* * *

THE WIRELESS AND ELECTRICAL TRADER YEAR BOOK, 1951

(Published in England, the comments below refer in the main to the United Kingdom.)

"The Wireless and Electrical Trader Year Book: Radio, Television, and Electrical Appliances, 1951." 22nd edition; published on 22nd May, 1951, at 10s. 6d. post free (with a reduction to subscribers to "Wireless and Electrical Trader") by Trader Publishing Co., Ltd. Size, demy 8vo, 8½ in. x 5¾ in.; 292 pages; bound paper boards.

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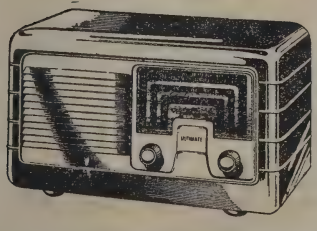

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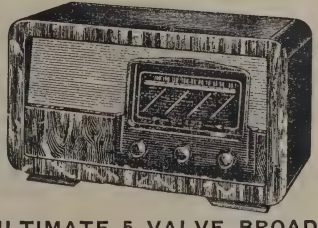

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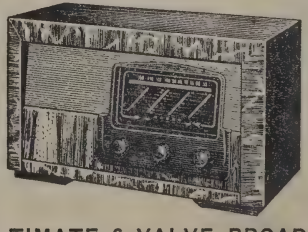

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In the latest edition—for 1951—considerable space has been devoted to television data designed to meet the needs of dealers in the areas in which the new television stations are to be opened later this year. This includes condensed specifications of current commercial television receivers (with such valuable facts as valves used, I.F. values, etc.) and information on valve and cathode-ray tube base connections, with more than 200 valve-base diagrams. These alone are invaluable to radio and TV service engineers.

Other time-saving data range from specifications of current radio receivers, legal information, and a directory of trade associations to a new section on TV test equipment and notes on licensing requirements as they affect the retailer.

Each year sees great changes in the names, addresses, telephone numbers, and products of the firms engaged in the radio and electrical industries. These revisions have been incorporated in the directory sections, and the lists of names and addresses of firms therefore make the "Year Book" an invaluable and time-saving desk companion for every retailer and business man in the industry.

"The Trader Year Book" will also prove of great assistance to overseas firms who are seeking contact with British suppliers.

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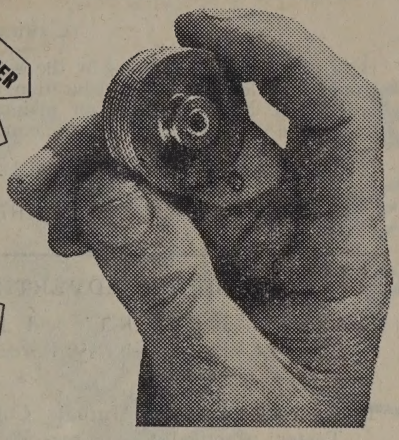

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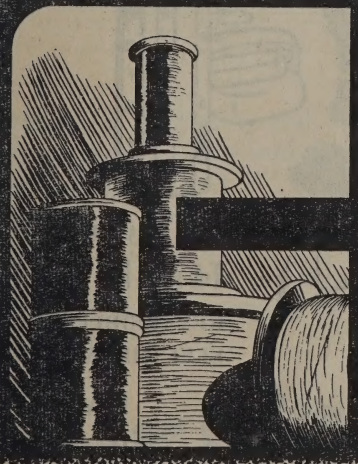

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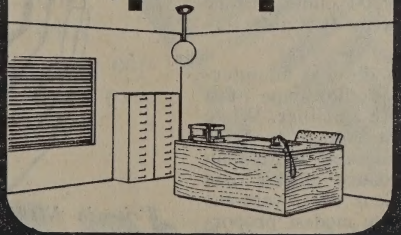

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Image Orthicon

(Continued from page 13.)

facture of the wire mesh that is placed on the photocathode side of the target. The purpose of this screen is to see that the secondary electrons emitted by the target are led off ,so that the potential of the target is stabilized. If this were not done, spurious signals would appear that bear no relation to the picture, and would cause undesired shading effects. This screen has a mesh much finer than the element structure of the picture, otherwise it would show as a grating over the picture area, and would limit the resolution obtainable. This means that the mesh must contain several hundreds of thousands of holes each of exactly the same size. Unfortunately, it is not possible in an article of this kind to go fully into the many fascinating details concerning the manufacture and design of the tubes, but it is hoped that the above may have given readers some small idea of what an astonishing device the camera tube is, and of the colossal amount of work that must have gone into its development.

Time Delay Circuits

(Continued from page 20.)

Engineering" for February, 1933. The tube is heated all the time. When a switch, in series with the B-supply, is closed the plate current starts flowing, but any increase in voltage drop across R_1 starts the charge of C and causes a voltage drop across R, making the grid negative and retarding the increase in plate current.

When the plate current has become normal, the relay pulls up. The rate of change can be controlled by the potentiometer, R_1, and the time is therefore dependent on the setting of R_1 as well as on the size of R and C. This arrangement is said to be little affected by variations in line voltage. A maximum variation of 5 per cent. may be expected for a fixed position of the potentiometer, R_1.

Shoes and Ships

(Continued from Page 22.)

500 ohms for low impedance lines; 200 ohms can be just as effective and less liable to extraneous interference from A.C. power lines, etc.

The writer had on one occasion to develop an interesting addition to the above system in the shape of a modulation level meter on the actual pre-amplifier. While it was simple enough to get sufficient voltage to drive the amplifier the meter required considerably more than was available, since the output impedance in this case had to be about 20 ohms. The problem was overcome by fitting a power output valve of quite modest proportions and characteristics in the cathode follower stage, inserting a choke in the plate circuit and bypassing the cathode resistor by a condenser except for that portion of the resistor used to feed the amplifier. The circuit finished up as shown in Fig. 3 with the meter being fed from the plate circuit through a D.C. isolating condenser. The choke in the plate circuit permitted high voltage on the anode and at the same time large variations at signal input frequencies to give adequate indication on the meter.

All of which goes to prove what a pleasant docile fellow the cathode follower can be. If however, you are an ex-member of the Luftwaffe, take it with a grain of salt; he's got many Jerries to his credit.

N.Z.E.I. Newsletter

(Continued from page 42.)

rightful place in electronics by the dissemination of electronic knowledge and the education of its members in order that New Zealand can maintain a standard of knowledge equivalent to that maintained in overseas countries.

For and on behalf of the Council,

W. L. HARRISON, *President.*

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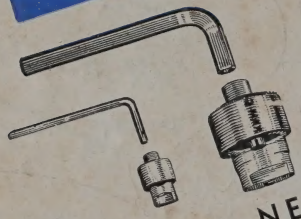

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